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Data Quality Objectives Summary Report for the 218-W-3A Burial Ground Contaminant Release Investigation

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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P.O. Box 1000
Richland, Washington

J. D. Aardal 08/16/2006
Release Approval Date

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TERMS

AA	alternative action
AEA	alpha energy analysis
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CH	contact handled
CLARC	cleanup levels and risk calculations
COC	contaminant of concern
COPC	contaminant of potential concern
CPT	cone penetrometer
CVAA	cold vapor atomic absorption
d/min	disintegrations per minute
DOE	U.S. Department of Energy
DQO	data quality objective
DR	decision rule
DS	decision statement
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FH	Fluor Hanford, Inc.
GC/MS	gas chromatography/mass spectrometry
GEA	gamma energy analysis
GPC	gas-proportional counting
GW	groundwater
HEPA	high-efficiency particulate air (filter)
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma/mass spectrometry
LSC	liquid scintillation counting
N/A	not applicable
NaI	sodium iodide
OVM	organic vapor monitor
ppb	parts per billion
ppbv	parts per billion by volume
ppmv	parts per million by volume
PSQ	principal study question
RCRA	*Resource Conservation and Recovery Act of 1976*
RH	remote handled
RL	U.S. Department of Energy, Richland Operations Office
RSW	retrievably stored waste
SAP	sampling and analysis plan
STOMP	subsurface transport over multiple phases (code)
SVOC	semivolatile organic compound
SWITS	*Solid Waste Information and Tracking System*

TBC	to be considered
TBD	to be determined
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	waste materials contaminated with more than 100 nCi/g of transuranic materials having half-lives longer than 20 years
VOC	volatile organic compound

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
inches	25.4	Millimeters	millimeters	0.039	inches
inches	2.54	Centimeters	centimeters	0.394	inches
feet	0.305	Meters	meters	3.281	feet
yards	0.914	Meters	meters	1.094	yards
miles	1.609	Kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	Hectares	hectares	2.47	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	Grams	grams	0.035	ounces
pounds	0.454	Kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			**Volume**		
teaspoons	5	Milliliters	milliliters	0.033	fluid ounces
tablespoons	15	Milliliters	liters	2.1	pints
fluid ounces	30	Milliliters	liters	1.057	quarts
cups	0.24	Liters	liters	0.264	gallons
pints	0.47	Liters	cubic meters	35.315	cubic feet
quarts	0.95	Liters	cubic meters	1.308	cubic yards
gallons	3.8	Liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			**Temperature**		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			**Radioactivity**		
picocuries	37	Millibecquerel	millibecquerel	0.027	picocuries

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1.0 STEP 1 – STATE THE PROBLEM

The purpose of data quality objective (DQO) Step 1 is to state the problem clearly and concisely and to ensure that the focus of the study is unambiguous.

1.1 INTRODUCTION

This DQO process has been performed to determine whether contaminants have been released to the vadose zone from retrievably stored waste (RSW) in the 218-W-3A Burial Ground in the 200 West Area of the Hanford Site. This investigation is to address *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989).

This summary report follows the process defined in EPA/600/R-96/055, *Guidance for the Data Quality Objectives Process*, EPA QA/G-4. This DQO leads to the development of the draft sampling and analysis plan (SAP) required by Tri-Party Agreement Interim Milestone M-91-40, Requirement 2, to be delivered to the Washington State Department of Ecology (Ecology) at least 45 days before initiating waste retrieval operations. The sampling design developed in this DQO will be carried over into the draft SAP for further development as a field-sampling document.

The following portions of Tri-Party Agreement Interim Milestone M-91-40, Requirement 2, pertain to this DQO.

> "As RSW retrieval proceeds, DOE [U.S. Department of Energy] shall sample and analyze trench substrates with the purposes of determining whether or not releases of contaminants to the environment have occurred, and, if so, the nature and extent of contamination.
>
> Such sampling and analysis shall be in accordance with Ecology approved sampling and analysis plans (SAP). The SAP will be developed using a DQO process to establish sampling requirements for sampling of burial ground vent risers and substrate soils. DOE provided Ecology with a draft 218-W-4C SAP on 8/12/03. Ecology's intention is to issue a final SAP within 30 days. With respect to the remaining burial grounds, DOE will provide Ecology with updated SAPs, if needed, for review and approval at least 45 days prior to starting retrieval in each burial ground. DOE will implement approved SAPs, as a requirement of this milestone, during retrieval of all RSW."

No field investigations have been conducted at the 218-W-3A Burial Ground. Thus, the sampling design will be guided by the sampling design developed for the 218-W-4C Burial Ground to maintain data comparability for all data generated in response to Tri-Party Agreement Interim Milestone M-91-40, Requirement 2.

Figure 1-1 shows the locations of the 200 West Area on the Hanford Site and of the 218-W-3A Burial Ground in the 200 West Area. Figure 1-2 shows the 218-W-3A Burial Ground trenches that contain RSW. Only segments of trenches contain RSW, as indicated in Figure 1-2.

Figure 1-1. Locations of the 200 West Area on the Hanford Site and of the 218-W-3A Burial Ground in the 200 West Area.

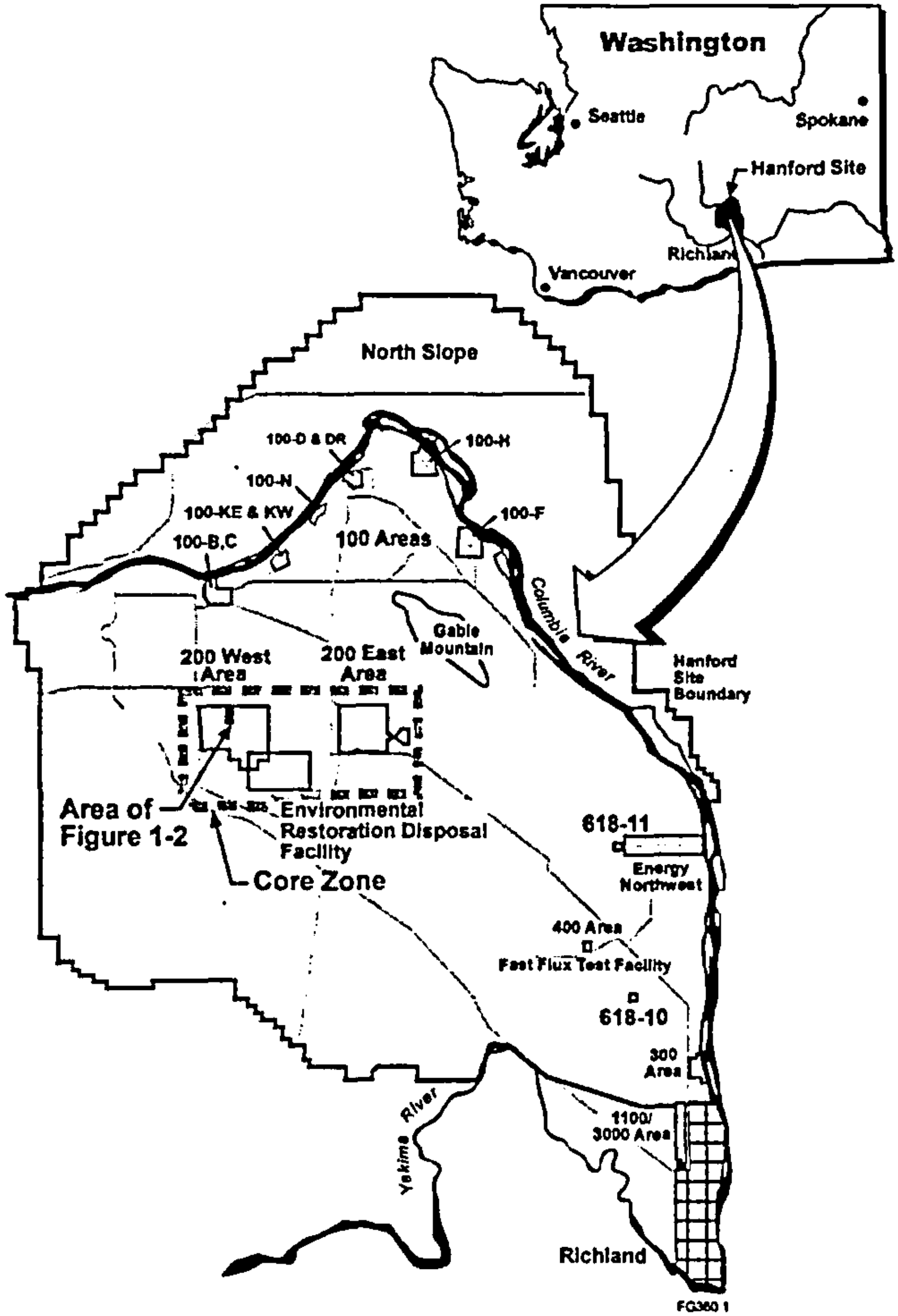
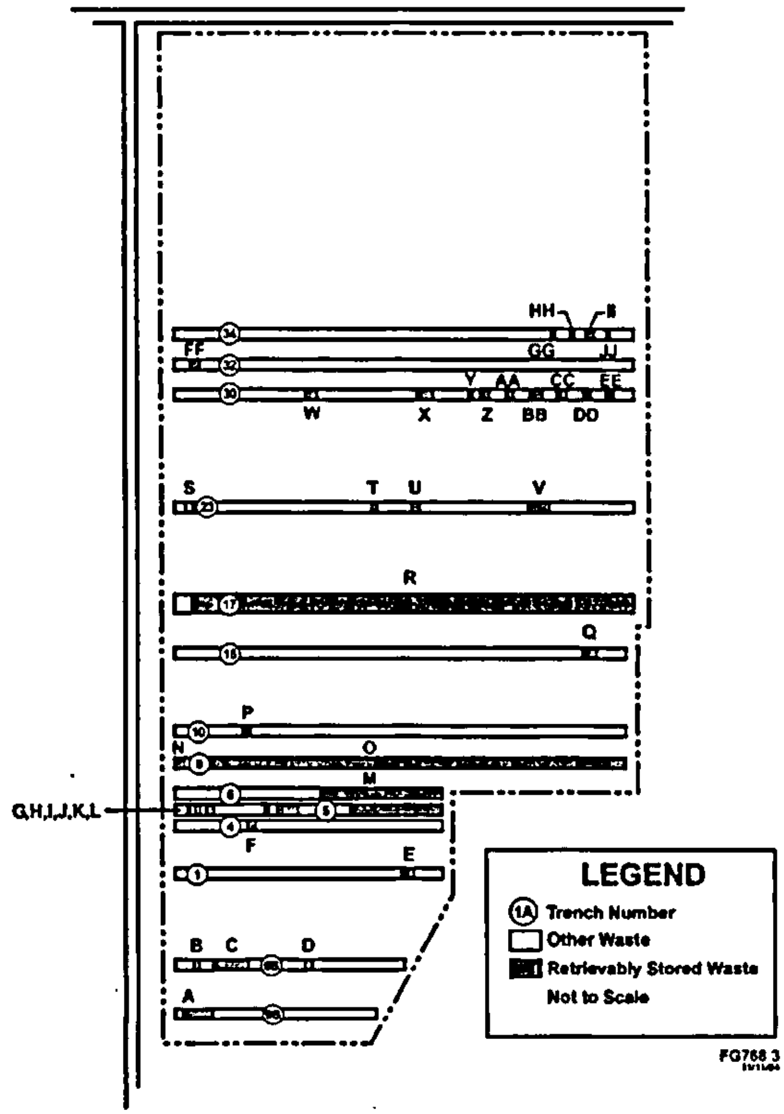


Figure 1-2. Location of the Trenches Containing Retrievably Stored Waste in the 218-W-3A Burial Ground.



1.2 PROJECT SCOPE

Tri-Party Agreement Interim Milestone M-91-40, Requirement 2, defines the scope of this project. It requires the DOE to sample and analyze substrate soils in the portions of the 218-W-3A Burial Ground trenches that contain RSW. The sampling is to determine whether contaminants have been released from the RSW to the environment and, if so, to identify the nature and extent of the contamination. Tri-Party Agreement Interim Milestone M-91-40, Requirement 2, further requires the issuance of a SAP. This DQO summary report provides the basis and documentation for developing the sampling design.

1.3 PROJECT OBJECTIVE

The objective of this DQO process is to develop the sampling and analytical activities and the requirements to determine the nature and extent of burial ground contaminants of concern (COC) in the 218-W-3A Burial Ground in accordance with Tri-Party Agreement Interim Milestone M-91-40, Requirement 2.

1.4 PROJECT ASSUMPTIONS

Project assumptions for the investigation are as follows.

- This DQO process follows EPA/600/R-96/055 guidance.
- The DQO activity for the 218-W-3A Burial Ground will be patterned after the DQO activities conducted separately for the 218-W-4C Burial Ground (CP-16886, *Data Quality Objectives Summary Report for the 218-W-4C Burial Ground Contaminant Release Investigation*) and the 218-W-4C Burial Ground SAP (DOE/RL-2003-48, *218-W-4C Burial Ground Sampling and Analysis Plan*), which has been reviewed and approved by Ecology. Because of differences between the configurations of the 218-W-4C and 218-W-3A Burial Grounds, the sampling design described in this document cannot correspond exactly to that followed at the 218-W-4C Burial Ground, but the design developed is intended to collect similar data with similar hold points built into the design.
- Sampling from vent risers in the 218-W-3A Burial Ground will be limited to the vent risers that currently exist, that are present in trenches where RSW is stored, and that are present in a section of the trench where records indicate that RSW is stored. The vent risers sampled must be accessible without posing health and safety risks to workers (e.g., because of the potential for subsidence) and must be risers from which a sample can be collected (i.e., the vent riser is intact and/or not clogged with soil).
- The design of the 218-W-3A Burial Ground included no emplacement of a gravel bed on the trench floor before waste was added to the trenches. Therefore, the surface that will be exposed following waste retrieval will be native soil.
- The information gathered in this investigation will be used to determine if contamination has been released to the vadose zone from retrievably stored[1] suspect transuranic (TRU)[2] waste in trenches in the 218-W-3A Burial Ground in accordance with Tri-Party Agreement Interim Milestone M-91-40, Requirement 2.
- The COCs are aligned with features and/or media in the burial grounds as follows. For vent riser sampling, the COCs will be volatile organic constituents. The COCs for the

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[1]Retrievably stored for purposes of the *Atomic Energy Act of 1954*.

[2]Waste materials contaminated with more than 100 nCi/g of transuranic materials having half-lives longer than 20 years.

substrate soils (i.e., the first 15.2 cm [6 in.] of native soils beneath the retrieved waste) include *Resource Conservation and Recovery Act of 1976* (RCRA) hazardous constituents (metals, volatile organics, and semivolatile organics). The COCs for native soils also include *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) radionuclides. The COCs are discussed in Section 1.8.

- This investigation only applies to the trenches in the 218-W-3A Burial Ground that contain RSW and only to those portions of those trenches from which RSW will be retrieved.

- The sampling design requires vent-riser sampling from those 218-W-3A Burial Ground trenches where RSW is stored and only from vent risers present in sections of the trenches where RSW is stored. This sampling must take place before waste retrieval is begun, because the vapor concentrations within the burial ground will be subject to mixing with outside air after waste retrieval begins.

- When the RSW has been retrieved from the 218-W-3A Burial Ground, these trenches still will contain waste that is not identified for retrieval under Tri-Party Agreement Interim Milestone M-91-40, Requirement 2.

- Pertinent 218-W-3A Burial Ground trench inspection records and/or occurrence reports regarding subsidence and/or flooding will be reviewed for indications of biased sampling locations.

- If hazardous constituents are found in the substrate soils, the path forward will be decided through the cleanup processes set forth in RCRA and/or CERCLA.

- The primary use of the data acquired through the sampling design developed in this report is defined in Tri-Party Agreement Interim Milestone M-91-40, Requirement 2. The objective is to characterize the substrate soils in the portions of the 218-W-3A Burial Ground where retrievably stored suspect TRU waste has been removed to determine whether or not contaminants have been released to the environment, and, if so, the nature and extent of the contamination. Other potential uses for the data include refining the 200-SW-2 Operable Unit preliminary conceptual contaminant distribution models, evaluating the risk assessment remedial action alternatives and remedial action decisions, and ensuring worker health and safety.

1.5 PROJECT ISSUES

Project issues can include global issues, which transcend the specific DQO project, and project technical issues, which are unique to the project. Global and project technical issues have the potential to affect the sampling design or the DQOs for the project.

1.5.1 Global Issues

No global issues were identified for this project.

1.5.2 Project Technical Issues

Project technical issues are technical issues that pertain exclusively to the project. The following project technical issues have been identified for this study.

Project Technical Issue #1: Based on the location of the RSW in the 218-W-3A Burial Ground, safety considerations may require waste management personnel to stabilize nearby waste that will not be retrieved under Tri-Party Agreement Interim Milestone M-91-40, Requirement 2, by reapplying a soil cover after retrieval of the RSW from the trench. In addition, remote-handled (RH) TRU waste could be encountered in the trenches. The RH TRU waste is not scheduled to be retrieved under Tri-Party Agreement Interim Milestone M-91-40. Health and safety considerations may not allow sampling close to RH TRU items that are left in place. Thus, all of the trench floor and substrate soils that underlie RSW may not be available to survey or sample once retrieval actions have been completed. This may slightly alter the planned sampling design by not allowing access to some randomly chosen locations.

Resolution: The designed sampling plan will allow for the addition of biased sample collection locations to augment those chosen based on the statistical sampling design to ensure that the data collected can be used to make the required decisions.

Project Technical Issue #2: Based on the location of the RSW in the 218-W-3A Burial Ground, the interim distance between the trenches may not safely support the weight of a truck. In addition, truck access to the trench floor may not be possible following waste retrieval. If truck access is not attainable, a cone penetrometer (CPT) or a GeoProbe[1] cannot be used to obtain vadose zone soil-vapor samples or substrate soil samples. This may alter the planned sampling design.

Resolution: The sampling design will allow for vadose zone soil-vapor samples to be collected using hand augering if CPT or GeoProbe equipment cannot be used. Use of hand augering likely will result in vadose zone soil-vapor samples only being collected from depths of 1.8 m (6 ft) or less.

Project Technical Issue #3: Based on the location of several modules of RSW in the 218-W-3A Burial Ground trenches, some COCs may be detected in soil-vapor sampling that are not attributable to the RSW. Rather, these COCs could be attributable to nearby, nonretrievably stored waste in the 218-W-3A Burial Ground trenches.

Resolution: The waste disposal records and data obtained during the waste retrieval activity will be evaluated to determine if COCs are attributable to nearby, nonretrievably stored waste rather than RSW.

Project Technical Issue #4: Based on the location of RSW drums within modules, the trench floor and substrate soils that underlie RSW may not be available to sample once retrieval actions have been completed.

[1]GeoProbe is a registered trademark of GeoProbe Systems, Salinas, Kansas.

Resolution: The sampling design will allow for surveys, smear samples, and visual observation or any combination of these techniques if soil samples cannot be obtained.

1.6 DATA QUALITY OBJECTIVE TEAM MEMBERS AND KEY DECISION MAKERS

To formulate the DQOs required to meet Tri-Party Agreement Interim Milestone M-91-40, Requirement 2, a team of appropriate technical personnel was assembled. The DQO team met in a workshop. Table 1-1 identifies the DQO workshop team members. DQO briefings also were held with the key decision makers listed in Table 1-2.

Table 1-1. Data Quality Objectives Workshop Team Members.

Name	Organization	Area of Expertise (Role)
Cliff Watkins	Portage Environmental, Inc.	DQO facilitator/workbook co-author, analytical chemistry, statistics
Melissa Armer	Portage Environmental, Inc	DQO workbook co-author, chemical engineering
Michael Cahill	FH Waste Management	Burial Grounds Operations (218-W-4B)
Tod Burrington	FH Waste Management	Burial Grounds Operations (218-W-3A)
Dan Saueressig	FH Waste Management	Burial Grounds Environmental Compliance
Lori Fritz	FH Waste Management	Waste Management Operations
John Winterhalder	FH Groundwater Remediation Program	Environmental Compliance
Larry Hulstrom	FH Groundwater Remediation Program	618-10/618-11 Burial Grounds lead
Steve Landsman/ Tom Bradfield	FH RadCon Engineering	Radiological engineering
Michelle Yates Mandis	Portage Environmental, Inc.	Historical research, environmental engineering
Bill Scott	Fluor Federal Services	Waste Retrieval Project – Project Engineer
Virginia Rohay	FH Groundwater Remediation Program	200-SW-2 Operable Unit lead, technical expert
Greg Thomas	FH Geosciences	Sample collection, waste management
Steve Trent	FH Sampling and Data Management	Analytical chemistry, data management

DQO = data quality objective.
FH = Fluor Hanford, Inc.
TRU = waste materials contaminated with more than 100 nCi/g of transuranic materials having half-lives longer than 20 years.

Table 1-2. Data Quality Objectives Key Decision Makers.

Name	Organization	Area of Expertise (Role)
Greg Sinton	RL	DOE project manager
Matt Mills	Ecology	Ecology project manager

DOE = U.S. Department of Energy.
Ecology = Washington State Department of Ecology.
RL = U.S. Department of Energy, Richland Operations Office.

1.7 BACKGROUND INFORMATION

The 218-W-3A Burial Ground is located west of the 221-T Building and north of the 218-W-3 Burial Ground. The burial ground was designed to contain 61 dry and industrial waste trenches running in an east-west direction. Four trenches have not been dug. Seven of the trenches are 163 m (535 ft) long, 35 of the trenches are 284 m (930 ft) long, and 10 are 275 m (900 ft) long. The remaining five trenches vary in length from 123 to 156 m (403 to 512 ft). Trench depths range from 3.7 to 5.8 m (12 to 19 ft). The distances between trench center points are all 12.2 m (40 ft) and based on this dimension, trench widths are estimated to be approximately 10.7 m (35 ft). The burial ground is marked and radiologically posted (*Waste Information Data System Report for 218-W-3A*, Hanford Site database).

The 218-W-3A Burial Ground is located in the low-level burial grounds RCRA treatment, storage, and disposal unit. The 218-W-3A Burial Ground also is included in the CERCLA 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit (DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*).

The 218-W-3A Burial Ground began operating in 1970 and contains approximately 100,000 m^3 (131,000 yd^3) of solid, dry, industrial wastes. The volume of suspect TRU waste is estimated to be 4,100 m^3 (5,363 yd^3) located in the following 14 trenches: T-9S, T-6S, T-01, T-04, T-05, T-06, T-08, T-10, T-15, T-17, T-23, T-30, T-32, and T-34 (Figure 1-2).

The 218-W-3A Burial Ground has no asphalt pads and used only earthen-bottom (potentially gravel fill) trenches. Drums were stacked horizontally in earthen trenches from 1970 until approximately 1974. The waste drums were "direct buried" in the ground without tarps or plywood to separate the soil overlying the waste. Direct contact with the soil may increase the probability that containers have corroded and might be breached. Figure 1-3 shows the drum placement configuration used in the 218-W-3A Burial Ground from 1970 to 1974. The actual date when tarp coverage was initiated has not been established. The coverage appears to vary based on types of containers and the storage area. After the transition period, drums were stacked vertically and placed on plywood and the completed module was covered with nylon tarps and plywood before soil emplacement (WHC-EP-0225, *Contact-Handled Transuranic Waste Characterization Based on Existing Records*). The 218-W-3A Burial Ground received TRU waste until 1987.

Figure 1-3. Drum Configuration of Retrievably Stored Waste in the 218-W-3A Burial Ground Trenches from 1970 to 1974.

(from WHC-EP-0912, *The History of the 200 Area Burial Ground Facilities*).

The TRU waste in Trench T-04 consists of 143 drums. The drums were disposed of from October 1974 through January 1975 and it is unclear whether the drums were direct buried or in modules with nylon covers.

Trench T-05 contains approximately 340, 208.2 L (55-gal) drums of TRU waste that is in several locations in the trench. All drums are expected to have been disposed of after 1975 and are assumed to be arranged in modules with plywood and a nylon cover to protect each module. Two 6.1 m (20-ft-) long 5.1 cm (2-in.-) diameter rigid polyvinyl chloride vent pipes were inserted through the plastic sheeting and taped to it. These plastic vent pipes extend to the bottom of the modules where they meet the trench floor soil surface. The bottoms of the pipes are cut at an approximately 45-degree angle that is open to the drum atmosphere (WHC-EP-0912, *The History of the 200 Area Burial Ground Facilities*).

Retrievable TRU waste in Trench T-06 consists of approximately 2,275 drums that were placed directly in the soil without a protective cover.

Trench T-08 is recorded to have about 460 waste drums stored as TRU waste and 75 assorted containers other than drums. Nineteen of these boxes are documented to be 1.5 by 1.5 by 1.9 m (5.5 by 5.5 by 6.25 ft), and the other three are 1.5 by 1.5 by 1.2 m (5.5 by 5.5 by 4 ft). These boxes take up approximately 82.3 m (270 ft) of the trench. The remainder of the trench is filled with various sized boxes, a decontamination tank, concrete culverts from Pacific Northwest Laboratory, and several modules of drums. The drums were disposed of after 1975 and are assumed to be arranged in modules with plywood and a nylon cover over each module. Seven 6.1 m (20-ft-) long, 5.1 cm (2-in.-) diameter rigid polyvinyl chloride vent pipes were inserted through the plastic sheeting and taped to it. These plastic vent pipes extend to the bottom of the modules where they meet the trench floor soil surface. The bottoms of the pipes are cut at an approximately 45-degree angle that is open to the drum atmosphere (WHC-EP-0912).

Trench T-17 contains only boxed waste totaling approximately 112 boxes. About 60 of the boxes are fiberglass-reinforced plywood boxes in various sizes.

Retrievably stored TRU waste in Trench T-23 consists of approximately six 208.2 L (55-gal) drums, seven plywood boxes, and one Hanford Site standard carton. This waste is located in several areas of the trench among the low-level waste. Trench T-30 contains about 30, 208.2 L (55-gal) drums that hold storage basin filters from the 105-KE Area, two 1.2 by 1.2 by 1.2 m (4 by 4 by 4 ft) plywood boxes, and boxed or wrapped reactor debris with activation product from the 105-N Reactor. These wastes are spread throughout the trench in eight locations. Trenches T-32 and T-34 also contain storage basin filters from the 105-KE Area. Trench T-32 contains two 1.2 by 1.2 by 1.2 m (4 by 4 by 4 ft) plywood boxes and Trench T-34 contains one 1.2 by 1.2 by 1.2 m (4 by 4 by 4 ft) plywood box, three 1.2 by 1.2 by 1.5 m (4 by 4 by 5 ft) wooden boxes, and one Hanford Site standard carton. The filters were bagged with desiccant and the wooden boxes are plastic lined (WHC-SD-W221-DP-001 and WHC-EP-0225).

This burial ground was flooded in the winter of 1979-1980, when several inches of snow on top of solidly frozen ground quickly melted and the associated runoff resulted in flooding. The burial ground was covered with standing water, almost continuous from the dirt road on the east side to the asphalt road on the west side of the burial ground (WHC-EP-0912).

In 1981, soil corrosion at the Hanford Site was estimated. Based on the measurements and observations of steel pipes and drums retrieved from soil, a corrosion rate of 5 mils/yr for uncoated or non-galvanized steel was predicted. A 1991 evaluation considered that this estimate could be somewhat conservative for stacked, painted drums and does not provide for the variable nature of corrosion. A better approximation of the range of expected corrosion of painted drums in soil is estimated to be 2.5 to 7.5 mils/yr for U.S. Department of Transportation 17H and 17C drums with 0.050 and 0.062 in. of steel-wall thickness, respectively. This range would yield a theoretical penetration in approximately 7 to 20 years for 17H drums and 8 to 25 years for 17C drums, depending on drum condition (WHC-EP-0225).

On January 21, 1997, a radiological control technician discovered contamination levels to 60,000 disintegrations per minute beta-gamma (no alpha) per 100 cm^2 in pieces of wind-blown tumbleweed at Trench T-26. The area in which the contamination was found is posted as an Underground Radioactive Materials Area (*Waste Information Data System Report for 218-W-3A*, Hanford Site database).

The number of containers and estimated dose rates for the RH and contact-handled (CH) waste in the 218-W-3A Burial Ground are summarized in Table 1-3. According to the *Solid Waste Information and Tracking System* (SWITS), 53 containers are classified as RH. RH waste, when exhumed, will require special handling that may include time, distance, and shielding to protect workers from radiation dose. Tri-Party Agreement Interim Milestone M-91-41 requires that full-scale retrieval of RH RSW be initiated by 2011. Sampling only will be conducted at the locations where CH RSW addressed by Tri-Party Agreement Interim Milestone M-91-40 is retrieved.

Table 1-4 summarizes the contents of the 218-W-3A Burial Ground by container type. The container types include drums, self-contained equipment, cardboard boxes, metal boxes, and high-efficiency particulate air (HEPA) filters. HEPA filters are identified as a container type. From the *Solid Waste Information and Tracking System* it is not clear if these HEPA filters are disposed of as is or if they are inside a container.

Table 1-5 lists the key existing documents and sources of data collected from previous investigations that the DQO team reviewed.

Table 1-3. Estimated Number of Containers, Sorted by Dose Rate, in the 218-W-3A Burial Ground

CH/RH	Dose Rate (mrem/h)	Number of Containers	% of Containers	Cumulative %
CH	≤200	3,525	98.5	98.5
RH	>200 to 1000	28	0.8	99.3
RH	>1000 to 2000	19	0.5	99.8
RH	>2000 to 5000	5	0.1	100.0
RH	>5000 to 10000	1	< 0.1	100.0
RH	>10000 to 20000	0	0	100.0
RH	>20000 to 30000	0	0	100.0
RH	>30000	0	0	100.0
Totals		3,578	100.0%	--

CH = contact handled.
RH = remote handled.

Table 1-4. Summary of the 218-W-3A Burial Ground Containers.

Suspect TRU Container Types in Burial Ground 218-W-3A Trenches		
Description	Quantity	Volume (m^3)
Fiberglass-reinforced plywood boxes	125	2962.8
Concrete boxes	29	114.3
Metal cylinder, casks	12	68.5
Self-contained equipment	1	23.9
Fiberboard/plastic boxes, cartons, cases	3	1.3
Miscellaneous scrap	1	1.1
Metal boxes, cartons, cases	12	172.7
Wooden boxes, cartons, cases	20	37.6
Trucks, flatbeds, compactor, loadlugger	1	0.7
Metal drums, barrels, kegs - 5-gal drums 4 (0.06 m^3) - 30-gal drums 78 (9.05 m^3) - 55-gal drums 3,279 (688.54 m^3)	3,361	697.6
Experimental Breeder Reactor EBR-II casks	5	3.5
High-efficiency particulate air filters	5	11.2
Ion exchange columns	1	2.2
Tanks, portable	2	9.5
Totals	3,578	4106.9

TRU = waste materials contaminated with more than 100 nCi/g of transuranic materials having half lives longer than 20 years.

Table 1-5. Existing Documents and Data Sources
for the 218-W-3A Burial Ground. (2 Pages)

Reference*	Summary
PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds, An Interim Report*	Summarizes site name, location, type status, site and process descriptions, known and suspected contamination, preliminary contaminant distribution conceptual model, site conditions that may affect COC fate and transport, COC mobility in Hanford Site soils, COC distribution and transport to groundwater, and hazards associated with COCs. Provides soil porosity information for each waste site.
WHC-EP-0912, *The History of the 200 Area Burial Ground Facilities*	Summarizes historical records and COCs.
WHC-SD-WM-RPT-056, *Solid Waste Stream Hazardous and Dangerous Components Study*, Rev. 0	Provides COC information.
WHC-SD-W221-DP-001, *Phase 2 Solid Waste Retrieval Trench Characterization*, Rev. 0	Provides COC information.
WHC-EP-0225, *Contact-Handled Transuranic Waste Characterization Based on Existing Records*	Provides historical and COC information.
RHO-CD-78, *Assessment of Hanford Burial Grounds and Interim TRU Storage*	Provides burial ground geology, physical dimensions, and other information.
RHO-MA-222, *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements*	Provides historical burial ground information, packaging, waste acceptance criteria, and storage information.
TRAC-0238, *200 Areas Fact Book*	Provides historical burial ground and container information.
DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, Rev. 0	Provides background geography, process, waste site, and COC knowledge and strategy for the 200 Areas.
RHO-CD-673, *Handbook 200 Areas Waste Sites*, 3 vols.	Provides waste site descriptions, list of releases, waste discharge information, and management reports.
BHI-01119, *Hanford Site Atlas*, Rev. 2	Contains Site maps.
Waste Information Data System Report for 218-W-3A, Hanford Site Database	Summarize site names, locations, types, status, site and process descriptions, associated structures, cleanup activities, environmental monitoring description, access requirements, references, regulatory information, and waste information (e.g., type, category, physical state, description, stabilizing activities).
PNNL-14548, *Hanford Site Groundwater Monitoring for Fiscal Year 2003*	Provides groundwater annual report information.
BHI-00175, *Z-Plant Aggregate Area Management Study Technical Baseline Report*, Rev. 00	Provides historical burial ground information, physical dimensions, and waste inventory.
DOE/RL-94-95, *Hanford Sitewide Groundwater Remediation Strategy*, Rev. 1	Provides groundwater and geological information.

Table 1-5. Existing Documents and Data Sources for the 218-W-3A Burial Ground. (2 Pages)

Reference*	Summary
DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*, Rev. 0	Summarizes site name, location, type status, site and process descriptions, known and suspected contamination, preliminary contaminant distribution conceptual model, site conditions that may affect COC fate and transport, COC mobility in Hanford Site soils, COC distribution and transport to groundwater, and hazards associated with COCs. Provides soil porosity information for each waste site.
WHC-SD-WM-TI-517, *Radioisotopic Characterization of Retrievably Stored Transuranic Waste Containers at the Hanford Site*	Provides COPC and historical information.
Hanford Environmental Information System database	Provides well information and sampling data.
Solid Waste Information and Tracking System database	Provides inventory and historical records.
Drawings	Construction "as-built" drawings of burial grounds.

*Full reference citations are located in Chapter 8.0.
COC = contaminant of concern.
COPC = contaminant of potential concern.

1.8 CONTAMINANTS OF CONCERN

Through the DQO process, a systematic methodology is used for identifying the COCs for each project. The 218-W-3A Burial Ground trenches received waste from various sources.

For vent riser sampling and active soil-vapor sampling in the vadose zone, the COCs will include only volatile organic constituents. Soil-vapor monitoring and radiation screening on the surface of the trench floor will be performed using hand-held instruments for total organic vapor concentrations and gross beta/gamma and gross alpha activities. Substrate soil samples from the first 15.2 cm (6 in.) of native soils will be analyzed for suites of RCRA constituents that include VOCs, SVOCs, and metals, and for a suite of CERCLA radiological constituents that are not subject to Tri-Party Agreement Interim Milestone M-91-40, Requirement 2. Source, special nuclear, and byproduct materials, as defined by the *Atomic Energy Act of 1954*, as amended, are excluded from the RCRA definition of solid waste. Such materials at the Hanford Site are subject to management under the sole authority of the DOE, even when commingled with a hazardous component that is subject to regulation under RCW 70.105, "Public Health and Safety," "Hazardous Waste Management," the Washington State Hazardous Waste Management Act of 1976. Accordingly, any procedures, methods, data, or information provided to regulatory agencies contained in this document that relate solely to radionuclides or to the radioactive component of mixed waste are for information purposes only and are outside the scope of the regulatory agencies' authority. Radionuclides, when they are COCs, may be regulated pursuant to CERCLA cleanup actions. The radionuclides discussed in this DQO are regulated pursuant to the *Atomic Energy Act of 1954* and CERCLA in accordance with responsible agency protocols. Radionuclides also may serve as indicators to assist in locating other specified contaminants.

The VOCs that will be analyzed in vent riser vapor samples and in vadose zone soil-vapor samples using field screening methods will depend on the availability and configuration of the specific field screening instrument used. The VOCs that will be analyzed in vent riser vapor samples and in vadose zone soil-vapor samples using laboratory analytical methods will include the full suite of VOCs identified in the laboratory test method. Vent riser vapor samples and vadose zone soil-vapor samples collected using active soil-vapor sampling techniques for laboratory analysis will be analyzed for VOCs using U.S. Environmental Protection Agency (EPA) methods that can identify individual VOCs in vapor mixtures:

- Method TO-14 (EPA/600/4-89/017, *Compendium of Methods for Determination of Toxic Organic Compounds in Ambient Air*)
- Method TO-15 (EPA/625/R-96/010b, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition*).

These methods are similar to the analytical methods used to analyze the soil-vapor samples collected using active sampling techniques at vent risers in the 218-W-4C Burial Ground in 1996 (HNF-SD-WM-RPT-309, *Report on Sampling and Analysis of Air at Trenches 218-W-4C and 218-W-5 #31 of the Low-Level Burial Grounds*) and in 2003 (CP-13514, *200-PW-1 Operable Unit Report on Step I Sampling and Analysis of the Dispersed Carbon Tetrachloride Vadose Zone Plume*).

To identify and quantify the metals, VOCs, and SVOCs in soil samples, full-suite analytical methods will be used. Soil samples will be analyzed for VOCs using SW-846 Method 8260B, for SVOCs using SW-846 Method 8270C, and for metals using EPA Method 200.8 (EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*) or SW-846 Method 6010B. (Comparable results for elemental mercury can be obtained using either EPA Methods 7470/7471 (cold vapor atomic absorption) in SW-846, or EPA Method 200.8 (inductively coupled plasma/mass spectrometry). The project's target quantitation limits will determine the methodology used for mercury analysis.) Tentatively identified compounds (i.e., organic constituents that are not contained in the calibration standards used for these analyses) also will be qualitatively identified by the full-suite analyses for VOCs and SVOCs and will be reported for evaluation. Soil samples will be analyzed for radionuclides by the appropriate laboratory methods used for individual isotopes and classes of radionuclides of concern.

The COCs for vent riser vapor samples and vadose zone soil-vapor samples, trench floor surveys, and soil samples are listed in Tables 1-6 through 1-8, respectively.

Table 1-6. Contaminants of Concern (Volatile Organic Compounds) for Vent Riser Vapor Sampling and Vadose Zone Soil-Vapor Sampling.

Volatile Organic Compounds
Field screening for: carbon tetrachloride and chloroform using the Innova[a] multigas analyzer and/or for acetone, ammonia, benzene, n-butyl alcohol, carbon dioxide, carbon disulfide, carbon tetrachloride, chlorobenzene, chloroform, p-dichlorobenzene, 1,1-dichloroethane, 1,2-dichloroethene, ethyl benzene, ethyl chloride (chloroethane), ethylene dichloride (1,2-dichloroethane), methane, methyl chloride (chloromethane), methyl chloroform (1,1,1-trichloroethane), methyl ethyl ketone (2-butanone), methyl isobutyl ketone (4-methyl-2-pentanone), methylene chloride, tetrachloroethene, styrene, toluene, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, trichloroethene, vinyl chloride, vinylidene chloride (1,1-dichloroethene), and xylene using the MIRAN SapphIRe Ambient Air Analyzer[b] (MIRAN analyzer). The VOCs listed for each field screening instrument are those for which that instrument is calibrated. The MIRAN analyzer has two operational modes. In one mode, the MIRAN analyzer can be used to scan for each of these compounds, but only one compound at a time in each run and without compensation for any potential cross-interference from other compounds. In the other mode, the MIRAN analyzer can be used to identify, in one run, up to five compounds from this list that best match the frequency spectrum of the sample.
Laboratory analysis for full suite of VOCs using EPA Method TO-14 (EPA/600/4-89/017) or EPA Method TO-15 (EPA/625/R-96/010b).

[a]Innova is a trademark of Innova AirTech Instruments A/S, Ballerup, Denmark.
[b]MIRAN and the SapphIRe Ambient Air Analyzer are registered trademarks of Thermo Electron Corporation, Franklin, Massachusetts.

EPA/600/4-89/017, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.*
EPA/625/R-96/010b, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition.*

EPA = U.S. Environmental Protection Agency.
GC/MS = gas chromatography/mass spectrometry.
VOC = volatile organic compound.

Table 1-7. Contaminants of Concern for Trench Floor Organic Vapor Monitoring/Radionuclide Surveys.

Volatile Organic Compounds
Surveys using hand-held monitoring devices (e.g., organic vapor monitoring) that detect total organic vapor concentrations.
Radionuclides
Surveys using hand-held monitoring devices that detect gross gamma/beta and gross alpha activities.

Table 1-8. Contaminants of Concern for Substrate Soil Sampling.

Metals
Laboratory analysis for full suite of metals using inductively coupled plasma (SW-846 Method 6010B or EPA Method 200.8) and for mercury (SW-846 Method 7471A or EPA Method 200.8[a]).
Volatile Organic Compounds
Laboratory analysis for full suite of VOCs using GC/MS (SW-846 Method 8260B).
Semivolatile Organic Compounds
Laboratory analysis for full suite of SVOCs using GC/MS (SW-846 Method 8270C).
Radionuclides
Laboratory analyses for a target list of radionuclides consisting of isotopic americium (AEA), isotopic plutonium (AEA), isotopic uranium (AEA), total radioactive strontium (GPC), Tc-99 (LSC), Cs-137 (GEA), Co-60 (GEA), Eu-152 (GEA), Eu-154 (GEA), Eu-155 (GEA), and Ni-63 (LSC) using AEA, GPC, LSC, or GEA as indicated.

[a] Comparable results for elemental mercury can be obtained using either EPA Methods 7470/7471 (cold vapor atomic absorption) in SW-846, or EPA Method 200.8 (inductively coupled plasma-mass spectrometry). The project's target quantitation limits will determine the methodology used for mercury analysis.

For EPA Method 200.8, see EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1.*

For 4-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition.*

AEA = alpha energy analysis.
EPA = U.S. Environmental Protection Agency.
GEA = gamma energy analysis.
GC/MS = gas chromatography/mass spectrometry.
GPC = gas proportional counting.
LSC = liquid scintillation counting.
SVOC = semivolatile organic compound.
VOC = volatile organic compound.

1.9 MILESTONE DATES

Table 1-9 lists the regulatory milestones and drivers associated with this project.

Table 1-9. Regulatory Milestones and Drivers.

Milestone	Due Date	Regulatory Driver
Provide draft 218-W-3A Burial Ground sampling and analysis plan.	45 days before initiating waste retrieval operations in the 218-W-3A Burial Ground	Tri-Party Agreement Interim Milestone M-91-40, Requirement 2*

**Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989).

1.10 PROJECT SCHEDULE

The DQO project schedule and the schedule drivers are listed in Table 1-10.

Table 1-10. Project Schedule.

Activity	Due Date	Driver
DQO Document		
Internal DQO workshop	November 2, 2004	DQO issuance in support of the SAP
RL briefing	November 17, 2004	
Regulator briefing	November 17, 2004	
Issue final DQO summary report	July 31, 2006	
SAP		
Draft SAP development	October 15-December 7, 2004	SAP issuance for Tri-Party Agreement Interim Milestone M-91-40, Requirement 2*
RL review	December 7-22, 2004	
Provide Draft A SAP to Ecology	August 29, 2005	

**Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989).
DQO = data quality objective.
Ecology = Washington State Department of Ecology.
RL = U.S. Department of Energy, Richland Operations Office.
SAP = sampling and analysis plan.

1.11 PRELIMINARY CONCEPTUAL CONTAMINANT DISTRIBUTION MODEL

Table 1-11 provides the relevant physical setting and background information.

Table 1-11. Preliminary Conceptual Contaminant Distribution Model Discussion. (2 Pages)

Physical Setting
The thickness of the vadose zone underlying the 218-W-3A Burial Ground is approximately 76 m (249 ft) and can be divided broadly into an upper gravel and sand interval (Hanford formation vadose zone), a silty sand and carbonate interval (Cold Creek unit), and a lower gravel and sand interval (Ringold Formation). The Cold Creek unit appears to be a major barrier to the vertical transport of water and contaminants in the subsurface. The surface of this unit is very irregular beneath the burial ground but has a minor overall slope to the south (WHC-SD-EN-TI-290). The regional flow of groundwater in the unconfined aquifer is from west of the Hanford Site toward the Columbia River. However, the local direction and rate of flow have been influenced by the discharge of wastewater to the soil column between 1944 and 1995, as a result of Hanford Site operations. In the past, groundwater may have moved from east to west under the 218-W-3A Burial Ground, but it now flows from west to east.
Nature and Extent of Contamination
Groundwater monitoring wells have been installed on the northern (299-W7-2, 299-W7-3, 299-W7-11) and southern (299-W10-19, 299-W10-20) perimeters of the 218-W-3A Burial Ground to comply with RCRA groundwater monitoring requirements. Carbon tetrachloride and nitrate are present above their maximum contaminant levels in the groundwater underlying the 218-W-3A Burial Ground. The most contaminated portion of the carbon tetrachloride groundwater plume (>4,000 ppb) in the 200 West Area is located beneath the Z Plant complex and extends radially about 500 m (1,640 ft). The 218-W-3A Burial Ground is located approximately 1,460 m (4,800 ft) north of the Z Plant complex. Nitrate and carbon tetrachloride routinely exceed drinking water standards in wells 299-W10-19 and 299-W10-20 with levels ranging from 5 to 1,000 ppb but are not believed to be a result of disposal practices at this site (PNNL-14548).

Table 1-11. Preliminary Conceptual Contaminant Distribution Model Discussion. (2 Pages)

Contaminant Release
The excavated trenches are expected to contain most of the contamination. Minor penetration of contaminants into the trench subsurface is expected to a depth of up to 3 m (10 ft), driven by instances of ponding snowmelt or rainwater above or at the trench floor. The contaminants most likely are held within the first 15.2 cm (6 in.) of native soil below the burial grounds. Contaminant penetration will be localized and irregular. Surface contamination is possible at shallow depths below and at the top of stabilizing soil covers, where plants, animals, and insects have brought the material to the surface. Contamination of the trench backfill may be encountered as a result of the failure of disposal packages, bio intrusion, and/or subsidence. Infiltration of rain water and snowmelt is expected to concentrate this material in the lower sloped portions of the trench. Ejection of contaminants at surface collapses will have produced a localized concentration around the subsequently backfilled voids (DOE/RL-96-81, Rev. 0). Runoff can accumulate in depressions and open trenches. Although unlikely, under unfavorable conditions (e.g., unusual precipitation event), migration to groundwater could occur in a relatively short time (estimated at 50 to 100 years) (DOE/RL-2000-72). Enhanced infiltration (e.g., resulting from collection of runoff in openings in collapsed containers that have large void spaces) could shorten the travel time to groundwater considerably from the estimated 50 to 100 years (DOE/RL-2000-72).

DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations.*
DOE/RL-2000-72, *Performance Assessment Monitoring Plan for the Hanford Site Low-Level Burial Grounds.*
PNNL-14548, *Hanford Site Groundwater Monitoring for Fiscal Year 2003.*
Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.
WHC-SD-EN-TI-290, *Geologic Setting of the Low-Level Burial Grounds*, Rev. 0.

pbb = parts per billion.
RCRA = *Resource Conservation and Recovery Act of 1976.*

1.12 CONCISE STATEMENT OF THE PROBLEM

Table 1-12 combines relevant background information into a concise statement of the problem to be resolved.

Table 1-12. Concise Statement of the Problem.

Problem Statement:
To assess whether contaminant releases to the environment have occurred from the retrievably stored waste that will be retrieved from the 218-W-3A Burial Ground, data are needed regarding concentrations of burial ground contaminants of concern in the substrate soils, in accordance with Tri-Party Agreement Interim Milestone M-91-40, Requirement 2.*

**Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989).

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2.0 STEP 2 – IDENTIFY THE DECISION

DQO Step 2 defines all of the principal study questions (PSQ) that need to be resolved to address the problems identified in DQO Step 1 and the alternative actions (AA) that would result from resolving the PSQs. The PSQs and AAs then are combined into decision statements (DS) that express a choice among AAs. Table 2-1 presents the task-specific PSQs and AAs and the resulting DSs. This table also provides a qualitative assessment of the severity of the consequences of selecting an incorrect AA. This assessment takes into consideration human health and the environment (flora and fauna) and political, economic, and legal ramifications. The severity of the consequences is expressed as low, moderate, or severe. Severe-consequence decisions generally indicate that statistically based sampling designs should be considered.

Table 2-1. Summary of Data Quality Objective Step 2 Information. (3 Pages)

PSQ-AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
PSQ #1 – Are the vapors sampled through the vent risers in the 218-W-3A Burial Ground trenches contaminated with VOCs?			
1-1	VOCs were detected. Add the detected VOCs to the COC list for the sampled 218-W-3A Burial Ground trenches and identify locations for subsequent trench floor surveys.	The COC list for the affected burial ground trenches would be needlessly over-conservative, and erroneous survey locations would be identified.	Low
1-2	VOCs were not detected. Do not add VOCs to the COC lists or identify survey locations.	The COC list for the affected burial ground trenches erroneously would not include VOCs that are present, and important survey locations would be omitted.	Moderate*
DS #1 – Determine if the vapors in the vent risers in the 218-W-3A Burial Ground trenches are contaminated with VOCs, and add the detected VOCs to the COC list for the sampled 218-W-3A Burial Ground trenches, and identify locations for subsequent trench floor surveys, or do not add to the COC list or identify survey locations.			

Table 2-1. Summary of Data Quality Objective Step 2 Information. (3 Pages)

PSQ-AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
PSQ #2 – Is the trench floor beneath the retrievably stored waste in the 218-W-3A Burial Ground chemically or radiologically contaminated?			
2-1	Trench floor indicates the presence of chemical or radiological contamination. Locations where contamination is indicated will be used to guide substrate soil characterization.	Characterization of substrate soil erroneously is performed in areas where surveys indicate contamination, yet none is present.	Low
2-2	Trench floor does not indicate the presence of chemical or radiological contamination. No additional locations will be used to guide substrate soil characterization.	Characterization of substrate soil erroneously is not performed in areas where contamination is present, because surveys of the trench floor did not identify the contamination.	Moderate*
DS #2 – Determine if the trench floor beneath the retrievably stored waste indicates chemical or radiological contamination and use areas of visually observed or detected contamination to guide substrate soil characterization, or if areas of contamination are not detected do not use these locations to guide substrate soil characterization.			
PSQ #3 – Do the soil-vapor samples or radiological surveys of cone penetrometer equipment used to collect samples in the vadose zone soils beneath the portions of trenches where retrievably stored waste has been retrieved indicate VOC or radiological contamination hot spots?			
3-1	Vadose zone soils are determined to contain hot spots of chemical or radiological contamination. Use hot-spot locations to guide substrate soil characterization.	Erroneous hot spots are identified, and substrate soil characterization needlessly is performed.	Low
3-2	Vadose zone soils are determined to not contain hot spots of chemical or radiological contamination. Hot-spot locations are not available to guide substrate soil characterization.	Hot-spot locations erroneously are not identified, and substrate soil characterization is not performed.	Moderate*
DS #3 – Determine if the soil-vapor samples or radiological surveys of cone penetrometer equipment used to collect samples in the vadose zone soils beneath the retrievably stored waste indicate hot spots of VOC or radiological contamination and use hot-spot locations to guide characterization of substrate soils and to add the detected COCs to the conceptual distribution model, or if hot-spot locations are not detected do not use these locations to guide characterization of the substrate soils and to add COCs to the conceptual distribution model.			

Table 2-1. Summary of Data Quality Objective Step 2 Information. (3 Pages)

PSQ-AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
PSQ #4 – Are substrate soils beneath the 218-W-3A Burial Ground Trenches that contained retrievably stored waste chemically or radiologically contaminated?			
4-1	Substrate soils are determined to be chemically or radiologically contaminated. Decision makers evaluate the need for additional characterization deeper in the vadose zone through the cleanup processes set forth in RCRA and/or CERCLA and add the detected COCs to the conceptual distribution model.	The evaluation of additional characterization deeper in the vadose zone erroneously is performed, and the conceptual distribution model erroneously is expanded.	Low
4-2	Substrate soils are determined to not be chemically or radiologically contaminated. Decision makers evaluate the data and decide against additional characterization deeper in the vadose zone and do not add the detected COCs to the conceptual distribution model.	The evaluation of characterization deeper in the vadose zone erroneously is not performed, and the conceptual distribution model erroneously is not expanded.	Moderate*
DS #4 – Determine if the substrate soils beneath the retrievably stored waste are chemically or radiologically contaminated, and decision makers evaluate the data and determine a need for additional characterization deeper in the vadose zone and/or to add the detected COCs to the conceptual distribution model, or decision makers evaluate the data and decide against additional characterization deeper in the vadose zone and/or adding COCs to the conceptual distribution model.			

*Severity of consequences is considered moderate, because additional characterization will be conducted at the 218-W-3A Burial Ground in the 200-SW-2 Operable Unit remedial investigation/feasibility study investigation.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.
Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.

AA = alternative action.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
COC = contaminant of concern.
DS = decision statement.
PSQ = principal study question.
RCRA = *Resource Conservation and Recovery Act of 1976.*
VOC = volatile organic compound.

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3.0 STEP 3 – IDENTIFY THE INPUTS TO THE DECISION

The purpose of DQO Step 3 is to identify the types of data needed to resolve the DSs identified in DQO Step 2. The data might exist already or might be derivable from computational or surveying and/or sampling and analysis methods. Analytical performance requirements (e.g., practical quantitation limit, precision, and accuracy) also are provided in this step for any new data that must be collected.

3.1 BASIS FOR SETTING THE PRELIMINARY ACTION LEVEL

The preliminary action level is the threshold value that provides the criterion for choosing between AAs. Table 3-1 identifies the basis (i.e., regulatory threshold or risk-based) for establishing the preliminary action level for each COC.

Table 3-1. Basis for Setting Preliminary Action Level.

DS #	COC	Basis for Setting Preliminary Action Level	Preliminary Action Levels
1	VOCs	Detected concentrations in vapor samples collected from vent risers, which may indicate the presence of contaminants in buried waste.	Compound-specific detection limits for the analytical equipment.[a]
2,3	VOCs and radiological contamination	Detected areas of contamination on the surface of the trench floor, detected VOC concentrations in vadose zone soil-vapor samples, and/or detected radiological contamination during surveys of vadose zone soil sampling equipment, which may indicate areas where substrate soil samples will be collected.	Visual indications (e.g., discoloration) on the trench floor, and compound-/isotope-specific detection limits for the analytical equipment.
4	VOCs, SVOCs, metals, and radionuclides	CLARC Version 3.1 tables (Ecology 94-145), 100 mrem/yr industrial exposure lookup values.	Chemical and/or radionuclide action levels in Table 3-7.[b]

[a]Decisions for DS #1, 2, and 3 will not be based on comparing vapor concentrations against cleanup levels, because no VOC vapor cleanup levels have been defined. Rather, decisions will be based on comparison of relative concentrations from the accumulated data.

[b]Preliminary action levels are provided for all but the SVOCs and VOCs. Suite-type analyses will be performed for these categories as noted in Section 1.8. The action levels will be determined for the detected analytes on a case-by-case basis.

Ecology 94-145, *Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation; CLARC, Version 3.1.*

COC = contaminant of concern.
DS = decision statement.
SVOC = semivolatile organic compound.
VOC = volatile organic compound.

3.2 INFORMATION REQUIRED TO RESOLVE DECISION STATEMENTS

Table 3-2 lists the data required to resolve each DS identified in Table 2-1 and identifies whether the data already exist. For the existing data, the references for the data have been provided with a qualitative assessment of whether or not the data are of sufficient quality to resolve the corresponding DS.

Table 3-2. Required Information and References.

DS #	Required Information Category	Do Data Exist? Y/N	Reference	Are Available Data of Sufficient Quality and Quantity to Support Decision Making? (Y/N)	Are Additional Data Required to Support Decision Making? (Y/N)
1	VOCs in vent riser vapor samples.	N	--	N/A	Y
2	VOCs or radiological contamination on the surface of trench floor.	N	--	N/A	Y
3	VOC contamination detected in soil-vapor samples from vadose zone soils and radiological contamination detected during surveys of sampling equipment used for soil-vapor sampling in the vadose zone.	N	--	N/A	Y
4	Chemical and radiological contamination in substrate soils.	N	--	N/A	Y

DS = decision statement.
N/A = not available.
VOC = volatile organic compound.

Data Gap Analysis

The VOC concentrations in vapors collected from vent risers, the VOC and radiological constituent concentrations on the trench floor and in the vadose zone soils, and the chemical and radiological constituent concentrations in the substrate soils beneath the buried waste have not yet been determined. Therefore, data gaps exist for the vapors present in the vent risers and for the soils immediately beneath the 218-W-3A Burial Ground.

3.3 COMPUTATIONAL AND SURVEY AND ANALYTICAL METHODS

Table 3-3 identifies the DSs where data do not exist or are of insufficient quality to resolve the DSs. For these DSs, Table 3-3 presents computational and/or surveying and sampling methods that could be used to obtain the required data.

Table 3-4 presents details on the computational methods identified in Table 3-3. These details include the source and/or author of the computational method and information on how the method could be applied to this study.

Table 3-5 identifies each survey and/or analytical method that may be used to provide the information needed to resolve each DS. Table 3-5 also provides the possible limitations associated with each of these methods.

Table 3-3. Information Required to Resolve the Decision Statements.

DS #	Remedial Investigation Variable	Required Data	Computational Methods	Survey/Analytical Methods
1	Concentrations of VOCs in vent riser vapor samples.	Measurement data for VOC concentrations in vapor collected from vent risers.	N/A	Collection and analysis of vent riser vapor samples.
2	Concentrations of organic vapors or radiological constituents on the surface of the trench floor soil.	Visual observations and data collected during retrieval operations indicating the presence of a potential hot spot. OVM and radionuclide screening data for contamination hot spots.	N/A	Visual observations made during retrieval operations. Soil-vapor sampling using an OVM and screening trench-floor soils for radionuclides using hand-held radiation detection instrumentation. Soil sampling and laboratory analysis.
3	Concentrations of VOCs or radiological constituents in vadose zone soil.	Measurement data for VOC concentrations in substrate soil-vapor.	N/A	Soil-vapor sampling using cone penetrometer of the substrate soil and radiological surveys of equipment retrieved from the substrate sampling locations.
4	Concentrations of chemical COCs in substrate soil.	Measurement data for metals, VOCs, and SVOCs: COC concentrations. Location data (depth and lateral extent of COCs within waste site boundaries).	Risk assessment. STOMP numerical modeling package to develop models for contaminant transport through vadose zone.	Laboratory analysis for metals using ICP, ICP/MS, or CVAA; and for VOCs, and SVOCs using GC/MS.

PNNL-12034, *STOMP, Subsurface Transport Over Multiple Phases, Version 2.0, User's Guide.*

COC = contaminant of concern.
CVAA = cold vapor atomic absorption.
DS = decision statement.
GC/MS = gas chromatography/mass spectrometry.
ICP = inductively coupled plasma.
ICP/MS = inductively coupled plasma/ mass spectrometry.
N/A = not applicable.
OVM = organic vapor monitor.
STOMP = subsurface transport over multiple phases (code) (PNNL-12034).
SVOC = semivolatile organic compound.
VOC = volatile organic compound.

Table 3-4. Details on Identified Computational Methods

DS #	Computational Method	Source/Author	Application to Study	Satisfy Input Reqmt?
4	STOMP	Pacific Northwest National Laboratory	STOMP is a numerical modeling package for developing models that can be used to estimate the migration of chemical contaminants through the vadose zone for indirect exposure.	Yes

PNNL-12034, *STOMP, Subsurface Transport Over Multiple Phases, Version 2.0, User's Guide.*

DS = decision statement.
STOMP = subsurface transport over multiple phases (code) (PNNL-12034).

Table 3-5. Potentially Appropriate Survey and/or Analytical Methods. (2 Pages)

Medium	Remediation Variable	Potentially Appropriate Survey/Analytical Method	Features/Possible Limitations
Field Analysis Samples			
Soil vapor	VOC concentrations in soil vapor	Membrane interface probe	Uses a probe similar to a cone penetrometer for vapor sampling. Capable of localized heating of soil to drive out residual VOCs from soil for subsequent vapor sampling and field analysis. Exact quantification is difficult because of matrix effects.
	VOC concentrations in vent risers	Soil gas collection for analysis in field using a gas chromatograph or other field-screening analyzer	Uses a GeoProbe®, cone penetrometer, or soil-vapor probe for access to subsurface and a pump to extract vapors for collection in Tedlar® bags or canisters. Vapors are analyzed in the field using portable GC or GC/MS instrumentation or other field-screening analyzer. Access depth may be limited by refusal.
Soil vapor	VOC concentrations in soil vapor	Cone sipper	Hand auger- or cone penetrometer-based sampling tool equipped with a sample chamber, tubing, and screen section for collecting sample vapor.
Soil	Concentrations of COCs in soil	Cone penetrometer wire-line sampler	Cone penetrometer-based wire-line tools enable sampling without retrieval of the cone penetrometer rods. The soil sampler provides 2.5 cm- (1-in.-) diameter soil samples that can be sealed and shipped for analysis.
	Soil permeability	Cone permeameter	Cone penetrometer-based method used to obtain in situ, depth-discrete measurements of soil permeability. It measures the subsurface pressure response to injected air or water.
	Concentrations of COCs in soil	Induced fluorescence	Uses ultraviolet light to induce an electronic transition to an excited state in target compounds. As it relaxes to a lower state, the compound emits light (fluorescence) that is detected. Some target analytes (e.g., carbon tetrachloride) do not fluoresce; however, in a mixture they may contain co-constituents that do fluoresce (e.g., oils).
	Microscopic conditions	Video microscope	Cone penetrometer-delivered video microscope provides a high-resolution (100 μm) color video of the subsurface materials.

Table 3-5. Potentially Appropriate Survey and/or Analytical Methods. (2 Pages)

Medium	Remediation Variable	Potentially Appropriate Survey/Analytical Method	Features/Possible Limitations
Soil or soil vapor	TBD	Innovative technologies	TBD
Laboratory Analysis Samples			
Soil vapor	VOC concentrations in soil vapor	Soil gas collection for analysis in a laboratory using a GC or GC/MS	Uses a GeoProbe, cone penetrometer, or soil-vapor probe for access to subsurface and a pump to extract vapors for collection in SUMMA® canisters. Vapors are analyzed in a permanent commercial or onsite laboratory. Access depth may be limited by refusal.
Soil vapor	VOC Concentrations in soil vapor	VOC collection for analysis in a laboratory using a GC or GC/MS	Flux chambers or cartridges are set on the overlying soil surface or in the subsurface and passively accumulate vapors on absorbent material for a fixed period of time (usually days). Useful for detecting trace amounts of VOC present in soil vapor. The flux chambers are removed from the environment, sealed for preservation, and sent to a laboratory for analysis of VOCs on GC or GC/MS instrumentation. Concentrations are reported in total nanograms per absorbent, rather than parts per billion by volume. Results may be reported as flux measurements (e.g., nanograms per square meter per minute).
Soil	Concentrations of COCs in soil	Cone penetrometer wire-line sampler	Cone penetrometer-based wire-line tools enable sampling without retrieval of the cone penetrometer rods. The soil sampler provides 2.5 cm- (1-in.-) diameter soil samples that can be sealed and shipped to a laboratory for analysis.
Vapor and Soil	Concentrations of COCs in soil	Direct soil sampling by sample spoons, EnCore® sampler, auger, split-spoon sampler, cone penetrometer testing, or other sample collection method for laboratory analysis	Highly radiologically contaminated samples require use of onsite laboratories, with associated impacts (e.g., high cost, reduced analyte lists, matrix effects, degraded detection limits, long turnaround times). Lower contamination levels allow use of offsite laboratories, thus avoiding these limitations.

EnCore is a registered trademark of En Novative Technologies, Inc. Green Bay, Wisconsin.
GeoProbe is a registered trademark of GeoProbe Systems, Salinas, Kansas.
SUMMA is a registered trademark of Moletrics, Inc., Cleveland, Ohio.
Tedlar is a registered trademark of E. I. du Pont de Nemours and Company, Wilmington, Delaware.

COC = contaminant of concern.
GC = gas chromatograph.
GC/MS = gas chromatography/mass spectrometry.
TBD = to be determined.
VOC = volatile organic compound.

3.4 ANALYTICAL PERFORMANCE REQUIREMENTS

Tables 3-6 and 3-7 define the analytical performance requirements for the chemical analyses that will be performed to produce data with the quality required to resolve each DS.
These performance requirements include the practical quantitation limit and the precision and accuracy requirements for each COC.

The analytical techniques, quality objectives, and performance requirements identified in Table 3-6 pertain to vapor measurement data for vent risers, trench-floor-surface, and vadose zone soil samples. Analytical techniques, quality objectives, and performance requirements identified in Table 3-7 pertain to data generated from laboratory analyses of substrate soil samples (if required). The use of specific analytical techniques depends mainly on the medium being sampled. The performance requirements then are assessed against the potentially applicable techniques listed in Table 3-5 and any practical constraints for data collection to select the methods required for characterizing the vapor present in the vent risers, the soil vapor from the vadose zone soils, and the substrate soil in the 218-W-3A Burial Ground.

Table 3-6. Analytical Performance Requirements for Vapor and Soil - Vapor Samples. (2 Pages)

Contaminant of Concern	Chemical Abstracts Service #	Preliminary Action Level[a]		Name/Analytical Technology	Target Required Quantitation Limits	Precision Vapor[b] (%)	Accuracy Vapor (%)
		TBD Industrial (mg/kg)	GW Protection (mg/kg)		Vapor		
Field-Screening Measurements							
Total VOCs	N/A	N/A	N/A	Organic vapor monitor[c]	10 ppmv	+/- 25	75 - 125
Carbon tetrachloride	56-23-5	N/A	N/A	Innova[d] analyzer	1 ppmv	+/- 25	75 - 125
	56-23-5	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer[e]	0.05 ppmv	+/- 25	75 - 125
Chloroform	67-66-3	N/A	N/A	Innova multigas analyzer	1 ppmv	+/- 25	75 - 125
	67-66-3	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	0.07 ppmv	+/- 25	75 - 125
Acetone	67-64-1				5 ppmv		
Ammonia	7664-41-7				0.7 ppmv		
Benzene	71-43-2				2 ppmv		
n-butyl alcohol	71-36-3				0.25 ppmv		
Carbon dioxide absolute	124-38-9				1 ppmv		
Carbon dioxide differential	124-38-9				1.5 ppmv		
Carbon disulfide	75-15-0				1 ppmv		
Chlorobenzene	108-90-7				0.4 ppmv		
p-dichlorobenzene	106-46-7				0.25 ppmv		
1,1-dichloroethane	75-34-3				0.4 ppmv		
1,2-dichloroethene	540-59-0				0.6 ppmv		
Ethyl benzene	100-41-4				1.2 ppmv		
Ethyl chloride (Chloroethane)	75-00-3	N/A	N/A	MIRAN SapphiIRe Ambient Air Analyzer	1 ppmv	+/- 25	75 - 125
Ethylene dichloride (1,2-dichloroethane)	107-06-2				0.7 ppmv		
Methane	74-82-8				1.5 ppmv		
Methyl chloride (Chloromethane)	74-87-3				1.7 ppmv		
Methyl chloroform (1,1,1-Trichloroethane)	71-55-6				0.15 ppmv		
Methylene chloride	75-09-2				4 ppmv		
Methyl ethyl ketone (2-butanone)	78-93-3				1.6 ppmv		
Methyl isobutyl ketone (4-methyl-2-pentanone)	108-10-1				0.35 ppmv		
Styrene	100-42-5				0.6 ppmv		

Table 3-6. Analytical Performance Requirements for Vapor and Soil - Vapor Samples. (2 Pages)

Contaminant of Concern	Chemical Abstracts Service #	Preliminary Action Level[a]		Name/Analytical Technology	Target Required Quantitation Limits	Precision Vapor[b] (%)	Accuracy Vapor (%)
		TBD Industrial (mg/kg)	GW Protection (mg/kg)		Vapor		
Toluene	108-88-3	N/A	N/A	MIRAN SapphiRe Ambient Air Analyzer	1 ppmv	+/- 25	75 - 125
Tetrachloroethene	127-18-4				0.09 ppmv		
1,1,2,2-tetrachloroethane	79-34-5				0.25 ppmv		
Trichloroethene	79-01-6				4 ppmv		
1,1,2-trichloroethane	79-00-5				0.25 ppmv		
Vinyl chloride	75-01-4				0.6 ppmv		
Vinylidene chloride (1,1-dichloroethene)	75-35-4				0.2 ppmv		
Xylene	1330-20-7				1.3 ppmv		
Laboratory Measurements							
Full suite of VOCs	Compound specific	N/A	N/A	Active soil-vapor analysis using Method TO-14 (EPA 600/4-89/017) or TO-15 (EPA 625/R-96-010b).	10 ppbv	+/- 25	70 – 130

[a]The preliminary action levels are N/A for this study (as noted in Table 3-1).
[b]The precision of the analyses using the MIRAN will be confirmed during calibration of the instrument.
[c]The organic vapor monitor will include an 11.8 eV lamp. The lamp will ionize and measure compounds with lower ionization potentials, such as carbon tetrachloride (ionization potential of 11.47 eV). However, the total concentration measured may include other volatile organic compounds with ionization potentials less than 11.8 eV.
[d]Innova is a trademark of Innova AirTech Instruments A/S, Ballerup, Denmark.
[e]MIRAN and the SapphIRe Ambient Air Analyzer are registered trademarks of Thermo Electron Corporation, Franklin, Massachusetts.

EPA/600/4-89/017, *Compendium of Methods for Determination of Toxic Organic Compounds in Ambient Air.*
EPA/625/R-96/010b, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition.*

EPA = U.S. Environmental Protection Agency.
GW = groundwater.
N/A = not applicable.
ppbv = parts per billion by volume.
ppmv = parts per million by volume.
TBD = to be determined.
VOC = volatile organic compound.

Table 3-7. Analytical Performance Requirements for Soil Samples. (4 Pages)

Contaminant of Concern	Chemical Abstracts Service #	Preliminary Action Level[a]		Name/Analytical Technology	Target Required Quantitation Limits		Precision Water (%)	Accuracy Water (%)	Precision Soil (%)	Accuracy Soil (%)
		TBC Industrial (pCi/g or mg/kg)	Groundwater Protection (pCi/g or mg/kg)		Water[b] Conc. (pCi/L or mg/L)	Soil-Other Conc. (pCi/g or mg/kg)				
Laboratory Measurements – Radionuclides[c]										
Americium-241	14596-10-2	22,400	TBD	Am AEA	1	1	±20	80-120	±35	65-135
Cesium-137	10045-97-3	156	TBD	GEA	15	0.1	±20	80-120	±35	65-135
Cobalt-60	10198-40-0	32.8	TBD	GEA	25	0.05	±20	80-120	±35	65-135
Europium-152	14683-23-9	78	TBD	GEA	50	0.1	±20	80-120	±35	65-135
Europium-154	15585-10-1	6.8	TBD	GEA	50	0.1	±20	80-120	±35	65-135
Europium-155	14391-16-3	2,840	TBD	GEA	50	0.1	±20	80-120	±35	65-135
Nickel-63	13981-37-8	4,026	TBD	Nickel-63 – liquid scintillation	15	30	±20	80-120	±35	65-135
Plutonium-238	13981-16-3	3,140	TBD	Pu AEA	1	1	±20	80-120	±35	65-135
Plutonium-239/240	Pu-239/240	2,840	TBD	Pu AEA	1	1	±20	80-120	±35	65-135
Strontium-90	Rad-Sr	16,060	TBD	Total radioactive strontium – GPC	2	1	±20	80-120	±35	65-135
Technetium-99	14133-76-7	2,740,000	TBD	Tc-99 – liquid scintillation	15	15	±20	80-120	±35	65-135
Uranium-234	13966-29-5	17,760	TBD	U AEA	1	1	±20	80-120	±35	65-135
Uranium-235	15117-96-1	674	TBD	U AEA	1	1	±20	80-120	±35	65-135
Uranium-238	U-238	3,360	TBD	U AEA	1	1	±20	80-120	±35	65-135
Laboratory Measurements – Metals										
Antimony	7440-36-0	1,400	5.42	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.06	6	±30	70-130	±30	70-130
Arsenic	7440-38-2	87.5	20[d]	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.1	10	±30	70-130	±30	70-130

Table 3-7. Analytical Performance Requirements for Soil Samples. (4 Pages)

Contaminant of Concern	Chemical Abstracts Service #	Preliminary Action Level[a]		Name/Analytical Technology	Target Required Quantitation Limits		Precision Water (%)	Accuracy Water (%)	Precision Soil (%)	Accuracy Soil (%)
		TBC Industrial (pCi/g or mg/kg)	Groundwater Protection (pCi/g or mg/kg)		Water[b] Conc. (pCi/L or mg/L)	Soil-Other Conc. (pCi/g or mg/kg)				
Barium	7440-39-3	245,000	923	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.2	20	±30	70-130	±30	70-130
Beryllium	7440-41-7	7,000	63.2	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.005	0.5	±30	70-130	±30	70-130
Cadmium	7440-43-9	3,500	0.81[d]	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.005	0.5	±30	70-130	±30	70-130
Chromium	7440-47-3	Unlimited	2,000	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.01	1	±30	70-130	±30	70-130
Copper	7440-50-8	130,000	22[d]	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.01	1	±30	70-130	±30	70-130
Lead	7439-92-1	Unlimited	840	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.1	10	±30	70-130	±30	70-130
Manganese	7439-96-5	490,000	50.2	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.05	5	±30	70-130	±30	70-130
Nickel	7440-02-0	70,000[f]	130.4	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.04	4	±30	70-130	±30	70-130
Selenium	7782-49-2	17,500	1[g]	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.1	10	±30	70-130	±30	70-130
Silver	7440-22-4	17,500	0.884	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.02	2	±30	70-130	±30	70-130

Table 3-7. Analytical Performance Requirements for Soil Samples. (4 Pages)

Contaminant of Concern	Chemical Abstracts Service #	Preliminary Action Level[a] TBC Industrial (pCi/g or mg/kg)	Preliminary Action Level[a] Groundwater Protection (pCi/g or mg/kg)	Name/Analytical Technology	Target Required Quantitation Limits Water[b] Conc. (pCi/L or mg/L)	Target Required Quantitation Limits Soil-Other Conc. (pCi/g or mg/kg)	Precision Water (%)	Accuracy Water (%)	Precision Soil (%)	Accuracy Soil (%)
Vanadium	7440-62-2	24,500	2,240	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.025	2.5	±30	70-130	±30	70-130
Zinc	7440-66-6	Unlimited	226	SW-846 Method 6010B (ICP) or EPA Method 200.8 (ICP/MS)	0.01	1	±30	70-130	±30	70-130
Mercury	7439-97-6	1,050	0.33[g]	SW-846 Method 7471A (CVAA) or EPA Method 200.8 (ICP/MS)[j]	N/A	0.20	N/A	N/A	±30	70-130
				SW-846 Method 7470A (CVAA) or EPA Method 200.8 (ICP/MS)[j]	0.0005	N/A	±30	70-130	N/A	N/A
Laboratory Measurements – Semivolatile Organics										
Full suite of SVOCs	Compound-specific	Compound-specific[e]	Compound-specific[e]	SW-846 Method 8270C (GC/MS)	0.02	0.33 to 0.85[h]	±30[f]	70-130[f]	±30[f]	70-130[f]
Laboratory Measurements – Volatile Organics										
Full suite of VOCs	Compound-specific	Compound-specific[e]	Compound-specific[e]	SW-846 Method 8260B[i] (GC/MS)	0.005	0.005 to 0.05[h]	±30[f]	70-130[f]	±30[f]	70-130[f]
Field-Screening Measurements – Radiological[k]										
Am-241	N/A	N/A	N/A	PG-2* NaI detector	N/A	5 pCi/g	N/A	N/A	±20	80-120
Gamma-emitting Radionuclides	N/A	N/A	N/A	Portable NaI detector	N/A	6.2 pCi/g	N/A	N/A	±20	80-120
Gross alpha	N/A	N/A	N/A	SHP380-A/B* Probe	N/A	90 d/min/100 cm^2 (fixed)	N/A	N/A	±20	80-120
				DP6DB* Probe		20 d/min/100 cm^2 (removable)				

Table 3-7. Analytical Performance Requirements for Soil Samples. (4 Pages)

Contaminant of Concern	Chemical Abstracts Service #	Preliminary Action Level[a]		Name/Analytical Technology	Target Required Quantitation Limits		Precision Water (%)	Accuracy Water (%)	Precision Soil (%)	Accuracy Soil (%)
		TBC Industrial (pCi/g or mg/kg)	Groundwater Protection (pCi/g or mg/kg)		Water[b] Conc. (pCi/L or mg/L)	Soil-Other Conc. (pCi/g or mg/kg)				

[a]The preliminary action levels for nonradionuclides are consistent with guidance contained in CLARC tables (Ecology 94-145) or risk-based values used to determine the appropriate analytical requirements (target required quantitation limits). The preliminary action levels for radionuclides are based on 100 mrem/yr above background and are used to determine appropriate analytical requirements.

[b]Water values for sampling quality control (e.g., equipment blanks/rinses) or drainable liquid (if recovered).

[c]Radiological contaminants of concern pertain to CERCLA activities only.

[d]WAC 173-340-900, "Tables," Table 740-1.

[e]No action levels are specified for general groupings of compounds; action levels are compound specific.

[f]Accuracy criteria are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if that control is more stringent. Additional analyte-specific evaluations also are performed for matrix spikes and surrogates as appropriate to the method. Precision criteria for batch laboratory replicate matrix sample analyses.

[g]Background value.

[h]Values shown are "nominal" compound-specific minimums and maximums. Most constituents will be within the given range. A limited number will have higher detection limits. Individual compounds will be evaluated against established laboratory contractual agreements (based on EPA guidance documents).

[i]SW-846 Method 5035A will be used as appropriate for VOC sampling and preservation.

[j]Comparable results for elemental mercury can be obtained using either EPA Methods 7470/7471 (cold vapor atomic absorption) in SW-846, or EPA Method 200.8 (inductively coupled plasma/mass spectrometry). The project's target quantitation limits will determine the methodology used for mercury analysis.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.
Ecology 94-145, *Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation; CLARC, Version 3.1.*
For 4-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition.*
For EPA Method 200.8, see EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1.*

*Trademarks:
DP6DB is a trademark of Thermo Electron Corporation, Minneapolis, Minnesota.
PG-2 is a trademark of Thermo Electron Corporation, Santa Fe, New Mexico.
SHP380-A/B is a trademark of Thermo Electron Corporation, Minneapolis, Minnesota.

AEA = alpha energy analysis.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
CLARC = cleanup levels and risk calculations.
CVAA = cold vapor atomic absorption.
d/min = disintegrations per minute.
EPA = U.S. Environmental Protection Agency.
GC/MS = gas chromatography/mass spectrometry.
GEA = gamma energy analysis.
GPC = gas proportional counting.
ICP = inductively coupled plasma.
ICP/MS = inductively coupled plasma/mass spectrometry.
N/A = not applicable.
NaI = sodium iodide.
SVOC = semivolatile organic compound.
TBC = to be considered.
TBD = to be developed.
VOC = volatile organic compound.

4.0 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

4.1 OBJECTIVE

In Step 4, the DQO team identifies the spatial, temporal, and practical constraints on the sampling design and considers the consequences, which ensures that the sampling design results in data being collected that accurately reflect the true condition of the site and/or populations being studied.

4.2 DEFINE THE BOUNDARIES OF THE STUDY

Table 4-1 defines the population of interest to clarify what the samples are intended to represent. The table also lists the characteristics that define the population of interest.

Table 4-1. Characteristics that Define the Population of Interest.

DS #	Population of Interest	Characteristics
1	The universe of vapor that can be sampled from the vent risers that are installed in trenches where RSW is stored and that are in the sections of these trenches where records indicate that RSW is stored in the 218-W-3A Burial Ground.	Vapor concentrations as indicators of the presence of burial ground contaminants of concern in the burial ground trenches.
2	The universe of exposed trench floor surfaces where RSW was stored that can be visually inspected or over which organic vapor monitoring or radiological surveys can be conducted.	Observed stains and concentrations of VOCs or radionuclides on trench floor soil surfaces as indicators of the presence of burial ground contaminants of concern in the substrate soils.
3	The universe of soil vapor that can be collected in the vadose zone soil below the retrieved RSW in the 218-W-3A Burial Ground.	Concentrations of VOCs in soil vapor and radiological contamination on sampling equipment as indicators of the presence of burial ground contaminants of concern in the vadose zone soils.
4	The universe of substrate soils found in contact with the buried, RSW in the 218-W-3A Burial Ground to a depth of 15.2 cm (6 in.) below the waste soil interface.	Contamination levels as indicators of contaminant migration from the waste into the substrate soils

DS = decision statement.
RSW = retrievably stored waste.
VOC = volatile organic compound.

Table 4-2 defines the spatial boundaries of the decision and the domain or geographic area (or volume) within which all decisions must apply (in some cases, this may be defined by the operable unit). The domain is a region distinctly marked by some physical features (e.g., volume, length, width, and boundary).

Table 4-2. Geographic Boundaries of the Investigation.

DS #	Geographic Boundaries of the Investigation
All	Retrievable waste storage portions of the 218-W-3A Burial Ground in Trenches T-9S, T-6S, T-01, T-04, T-05, T-06, T-08, T-10, T-15, T-17, T-23, T-30, T-32, and T-34.

DS = decision statement.

In this part of DQO Step 4, the populations of interest may be divided into strata that have unique characteristics. The ultimate goal is to define the decision units important to the sampling design. The DQO team must evaluate process knowledge, historical data, and plant configurations to establish the logic that supports alignment of the populations into strata and decision units.

The strata of interest for the 218-W-3A Burial Ground investigation are shown in Table 4-3. Delineating the strata allows the development of spatial decision units.

Table 4-3. Strata with Homogeneous Characteristics.

DS #	Population of Interest	Strata	Homogeneous Characteristic Logic
1	The universe of vapor that can be sampled from the vent risers that are installed in trenches where RSW is stored and that are in the sections of these trenches where records indicate that RSW is stored in the 218-W-3A Burial Ground.	Vapor in the vent risers and buried solid waste cavity.	Vapor samples collected from the vent risers atop the 218-W-3A Burial Ground can be used to indicate the presence of VOCs in the buried waste trenches. This is a simple and inexpensive screening activity.
2	The universe of exposed trench floor surfaces where RSW was stored that can be visually inspected or over which organic vapor monitoring or radiological surveys can be conducted.	Native soils at the point of soil-waste contact.	Visual staining, vapor, and radiation emanating from soil on the surface of the trench floor can be used to indicate the presence of VOCs or other contaminants of concern in the substrate.
3	The universe of soil vapor that can be collected in vadose zone soil below the retrieved RSW from the 218-W-3A Burial Ground.	Native soils beneath the waste to a depth of 9.8 m (32 ft).	Vadose zone soils contaminated by migration of condensate and/or organic solvents that could act as a carrier medium to the lower portions of the vadose zone.
4	The universe of substrate soil samples that can be collected from the native soils below the retrieved RSW in the 218-W-3A Burial Ground to a depth of 15.2 cm (6 in.) below the waste soil interface.	Native soils beneath the waste to a depth of 15.2 cm (6 in.).	Substrate soils contaminated by migration of condensate and/or organic solvents that could act as a carrier medium to the lower portions of the vadose zone.

DS = decision statement.
RSW = retrievably stored waste.
VOC = volatile organic compound.

As identified in the problem statement, the substrate soils represent the primary medium of interest. As such, the sampling designs developed for the vent risers, trench floor, and vadose zone soil vapor are only to determine the status of the substrate soils beneath the waste.

The survey methods employed during the analysis of the vent riser vapor, trench floor, and vadose zone soil vapor will be used as a guide in determining sampling locations for substrate soil samples for låboratory analyses following waste retrieval.

The temporal boundaries of the investigation are defined in Table 4-4.

Table 4-4. Temporal Boundaries of the Investigation.

DS #	Timeframe	When to Collect Data
1	TBD	Before waste retrieval
2, 3, 4	TBD	After all contact-handled waste that will be retrieved has been removed and when the section of the trench floor has become accessible and sampling activities will not interfere with waste retrieval operations

DS = decision statement.
TBD = to be determined.

4.3 SCALE OF DECISION MAKING

Table 4-5 defines the scale of decision making for each DS. The scale of decision making is defined as the smallest, most appropriate subsets of the population (subpopulation) for which decisions will be made based on the spatial or temporal boundaries of the area under investigation.

Table 4-5. Scale of Decision Making.

DS #	Population of Interest	Geographic Boundary	Temporal Boundary		Decision Units
			Time Frame	When to Collect Data	
1	The universe of vapor that can be sampled from the vent risers that are installed in trenches where RSW is stored and that are in the sections of these trenches where records indicate that RSW is stored in the 218-W-3A Burial Ground.	Retrievable waste storage portions of the 218-W-3A Burial Ground Trenches.	TBD	Before waste retrieval.	218-W-3A Burial Ground vent risers and suspect TRU RSW buried solid waste cavities.
2	The universe of exposed trench floor surfaces where RSW was stored that can be visually inspected or over which organic vapor monitoring or radiological surveys can be conducted.			After all contact-handled waste that will be retrieved has been removed and when the section of the trench floor has become accessible and sampling activities will not interfere with waste retrieval operations.	Native soils contaminated by migration of condensate and/or organic solvents from the waste into the substrate soil.
3	The universe of soil vapor that can be collected in vadose zone soil below the retrieved RSW from the 218-W-3A Burial Ground.				
4	The universe of substrate soil samples that can be collected from the native soils below the retrieved RSW in the 218-W-3A Burial Ground to a depth of 15.2 cm (6 in.) below the waste soil interface.				

DS = decision statement.
RSW = retrievably stored waste.
TBD = to be determined.
TRU = waste materials contaminated with more than 100 nCi/g of transuranic materials having half-lives longer than 20 years.

4.4 PRACTICAL CONSTRAINTS

The following practical constraints could affect data collection. These constraints are physical barriers, difficult sample matrices, health and safety concerns, and any other condition that will need to be considered in the design and scheduling of the sampling program.

- Sampling by CPT could be depth-limited because of geologic features that cause refusal.
- Health and safety constraints could be imposed during characterization sampling to ensure that issues are properly addressed when sampling potentially contaminated soils.
- Laboratory constraints are expected when analyzing soil samples that have TRU (or other radionuclide) contaminants above concentrations that result in added safety constraints on analytical operations. Soil samples in this category would be analyzed in an onsite laboratory. Cost and detection-limit impacts are expected. If the onsite laboratory has analytical capacity issues, analyses that have short hold times could be performed after the hold time has been exceeded.
- Some analytical methods are constrained when contaminants are present at high concentrations. The presence of a contaminant in high concentration may result in interference in the ability to detect other contaminants that are present at low concentrations.
- Extreme weather conditions could limit or shut down field operations.
- Access to some vent riser locations at the burial ground could be limited because of subsidence, no-walking zones, or other worker health and safety issues.
- Access to certain trench floor and subsurface soil locations could be hindered by the presence of certain waste containers (e.g., RH or non-RSW materials).
- The RSW is adjacent to waste in the same trench that is not RSW. Because of this, some sampling locations may not be accessible because soil used to cover adjacent non-RSW for safety reasons following retrieval of the RSW could hinder access.

5.0 STEP 5 – DEVELOP A DECISION RULE

DQO Step 5 initially defines the population parameter of interest (e.g., maximum concentration, mean concentration). The parameter of interest is estimated by a statistic that is calculated using the measurement data obtained. In this step of the DQO process, the statistic that will be used to estimate the parameter of interest is specified (e.g., the sample mean as estimated by the value of the 95 percent upper confidence level of the sample distribution). The statistic chosen is used for comparison against the action level. The population parameter of interest specifies the characteristic or attribute that a decision maker would like to know about the population. The preliminary action level for each COC also is identified in DQO Step 5. Using the population parameter of interest and the action level, a decision rule (DR) is developed for each DS in the form of an "IF...THEN..." statement that incorporates the statistic that will be used to estimate the parameter of interest, the scale of decision making, the preliminary action level, and the AAs that would result from the decision resolution. The scale of decision making and the AAs were identified in DQO Steps 4 and 2, respectively.

5.1 INPUTS NEEDED TO DEVELOP DECISION RULES

Tables 5-1, 5-2, and 5-3 present the information needed to formulate the DRs in Section 5.2. This information includes the DSs and AAs identified in DQO Step 2, the scale of decision making identified in DQO Step 4, the population parameters of interest, and the preliminary action levels for each COC.

Table 5-1. Decision Statements.

DS #	Decision Statement
1	Determine if the vapors in the vent risers in the 218-W-3A Burial Ground trenches are contaminated with VOCs and add the detected VOCs to the COC list for the sampled 218-W-3A Burial Ground trenches, and identify locations for subsequent trench floor surveys, or do not add to the COC list or identify survey locations.
2	Determine if the trench floor beneath the retrievably stored waste indicates chemical or radiological contamination and use areas of visually observed or detected contamination to guide substrate soil characterization or, if areas of contamination are not detected do not use these locations to guide substrate soil characterization.
3	Determine if the soil vapor samples or radiological surveys of cone penetrometer equipment used to collect samples in the vadose zone soils beneath the retrievably stored waste indicate hot spots of VOC or radiological contamination and use hot-spot locations to guide characterization of substrate soils and to add the detected COCs to the conceptual distribution model, or if hot-spot locations are not detected do not use these locations to guide characterization of the substrate soils and to add COCs to the conceptual distribution model.
4	Determine if the substrate soils beneath the retrievably stored waste are chemically or radiologically contaminated, and decision makers evaluate the need for additional characterization deeper in the vadose zone and to add the detected COCs to the conceptual distribution model, or decision makers evaluate the data and decide against additional characterization deeper in the vadose zone and adding COCs to the conceptual distribution model.

COC = contaminant of concern.
DS = decision statement.
VOC = volatile organic compound.

Table 5-2. Inputs Needed to Develop Decision Rules.

DS #	COCs	Parameter of Interest	Scale of Decision Making	Action Levels
1	VOC vapors	Detected or maximum detected concentrations.	218-W-3A Burial Ground vent risers and buried solid waste cavities..	Compound-specific detection limits for the analytical equipment.
2	VOC vapors	Detected concentrations.	Trench floor in burial ground trench.	Visual evidence of staining of the trench floor from the presence of solvents, and/or compound-specific detection limits for the analytical equipment.
	Radiological contamination	Detected activity.		Background radiation detected by the field detector.
3	VOC vapors	Detected concentrations.	Vadose zone soils underlying the RSW trenches in the 218-W-3A Burial Ground.	Compound-specific detection limits for the analytical equipment.
	Radiological contamination	Detected activity.		Background radiation detected by the field detector.
4	VOCs, SVOCs, metals, and radionuclides in soil samples	Detected concentrations.	Substrate soil beneath the RSW trenches in the 218-W-3A Burial Ground.	Chemical and/or radionuclide* preliminary action levels specified in Table 3-7.

*Radiological COCs pertain to CERCLA activities only.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
COC = contaminant of concern.
DS = decision statement.
RSW = retrievably stored waste.
SVOC = semivolatile organic compound.
VOC = volatile organic compound.

5.2 DECISION RULES

The output of DQO Step 5 and the previous DQO steps are combined into "IF...THEN" DRs that incorporate the parameter of interest, the scale of decision making, the action level, and the actions that would result from resolving the decision. The DRs are listed in Table 5-3.

Table 5-3. Decision Rules.

DR #	Decision Rule
1	If the VOC vapor concentrations measured in samples collected from the vent risers in the RSW trenches in the 218-W-3A Burial Ground are greater than the compound-specific detection limits* for the analytical equipment, then add the detected VOCs to the COC list for sampled trenches and use the detected or maximum detected concentrations to identify the locations for subsequent trench floor surveys; otherwise do not add to the COC list or identify survey locations.
2	If the trench floor beneath the RSW has visual indications of staining from contact with organic solvents, and/or the detected VOC vapor concentrations on the trench floor surface are greater than the compound-specific detection limits* for the analytical equipment, and/or the detected radiological activity on the trench floor is greater than the background radiation detected by the field detector, then use the hot-spot locations to guide substrate soil characterization beneath the surface of the trench floor; otherwise, hot-spot locations are not available to guide substrate soil characterization.
3	If the VOC soil-vapor concentrations in the vadose zone soil underlying the trench floor are greater than the compound-specific detection limits* for the analytical equipment, and/or the detected radiological activity on sampling equipment removed from the subsurface during this vadose zone soil-vapor sampling is greater than the background radiation detected by the field detector, then use those locations to guide substrate soil characterization; otherwise, hot-spot locations are not available to guide substrate soil characterization.
4	If the detected chemical or radiological constituent concentrations in the substrate soils beneath the trench floor are greater than the action levels defined in Table 3-7, then decision makers will evaluate the need for additional characterization deeper in the vadose zone through the cleanup processes set forth in RCRA and/or CERCLA and will add the identified COCs to the conceptual distribution model; otherwise, decision makers will evaluate the data and decide against additional characterization deeper in the vadose zone and adding COCs to the conceptual distribution model.

*Limits are presented in Table 3-6 of this data quality objective report.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.
Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
COC = contaminant of concern.
DR = decision rule.
RCRA = *Resource Conservation and Recovery Act of 1976.*
RSW = retrievably stored waste.
VOC = volatile organic compound.

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6.0 STEP 6 – SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

Because analytical data only can estimate the true condition of the site under investigation, decisions that are made based on measurement data potentially could be in error (i.e., decision error). For this reason, the primary objective of DQO Step 6 is to determine which DRs, if any, require a statistically based sample design. For those DRs requiring a statistically based sample design, DQO Step 6 defines tolerable limits on the probability of making a decision error. For sampling designs that are nonstatistically based (i.e., judgmental), uncertainty is evaluated qualitatively to estimate decision error.

The charter for the characterization in this study is Tri-Party Agreement Interim Milestone M-91-40, Requirement 2. The directive in the milestone includes initial sampling through vent risers in the burial grounds before waste retrieval. Vent riser sampling will be performed in the 218-W-3A Burial Ground as it was in the 218-W-4C Burial Ground (i.e., in trenches where records indicate the presence of RSW and vent risers are present, intact, and accessible). The vent-riser locations are an artifact of the burial ground design and were not determined by a statistical sampling design. Therefore, the sampling design for vapor sampling through vent risers is nonstatistical. The uncertainty associated with the decisions to be made based on determining whether the vapors in the vent risers are contaminated with VOCs is considered to be relatively low. Because many organic vapors are denser than air, sampling from the bottom of the vent riser near the base of the trench will sample from the area most likely to contain contaminated vapors.

A focused sampling approach will be used to guide selection of locations for vadose zone soil-vapor sampling and soil sampling in the substrate soils following waste retrieval. Sampling locations will be based on the following:

- Results of the vent riser vapor sampling conducted before waste retrieval
- Visual observations of the trench floor for indications of discoloration, staining, or bleaching that could be caused by leakage of organic solvents or other liquid waste from drums
- Organic monitoring and radiological surveys conducted on the trench floor and during sample collection activities
- Results of previous soil-vapor sampling.

The uncertainty associated with the decisions to be made based on determining whether the trench floor or substrate soils are contaminated is considered to be relatively low. The uncertainty associated with missing a hot spot is quantified in the statistically based hot-spot sampling design (Appendix A). That, coupled with collecting additional samples at biased locations based on visual observations, conducting surveys of the soil vapor on the trench floor and in substrate soils, and conducting radiological surveys during sample collection, further reduces the likelihood of missing an existing hot spot if one is present.

The statistically based hot-spot sampling design is a form of random sampling. For the substrate soil sampling, the size and shape of the elliptical target of interest and the chance of missing an existing hot spot are specified. Once these specifications are made, the grid spacing required to detect a hot spot within the desired specification can be estimated. The location of the first grid node is chosen randomly, and the grid is laid out from there. For the substrate soil sampling, the decision makers must specify the length of the semimajor axis of the smallest hot spot important to detect, the expected shape of the elliptical target, and an acceptable probability of not finding the hot spot. The probability of not finding a hot spot is equivalent to the false positive decision error (i.e., determining that no COCs are present in the soil vapor, because no hot spot was found, when a hot spot actually exists). If a statistically based sampling design is implemented for substrate soil and/or vadose zone characterization, the proposed length of the semimajor axis is 4.9 m (16 ft), the proposed shape of the elliptical target is an ellipse with a major axis-to-minor- axis ratio of 1:0.8, and the proposed acceptable probability of not finding a hot spot is 10 percent. To provide this level of certainty, a sample spacing of 7.6 m (25 ft) is needed.

7.0 STEP 7 – OPTIMIZE THE DESIGN

7.1 PURPOSE

DQO Step 7 identifies the most resource-effective design for generating data to support decisions while maintaining the desired degree of precision and accuracy. When determining an optimal design, the following activities should be performed.

- Review the DQO outputs from the previous DQO steps and the existing environmental data.
- Develop general data-collection design alternatives.
- Select the sampling design (e.g., techniques, locations, numbers, and volumes) that most cost-effectively satisfies the project's goals.
- Document the operational details and theoretical assumptions of the selected design.

7.2 OPTIMIZE THE DESIGN

Table 7-1 identifies information related to determining the data collection design.

Table 7-1. Determine Data Collection Design.

DR #	Statistical	Nonstatistical	Rationale
1	N/A	Nonstatistical sampling design.	Judgmental data collection design applies to the vent-riser vapor sampling, because the sampling parameters are fixed by virtue of the *Hanford Federal Facility Agreement and Consent Order* Interim Milestone M-91-40, Requirement 2 and the locations of the vent risers in the 218-W-3A Burial Ground.
2	Trench floor survey for VOC vapors and radionuclides to identify hot spots across the entire accessible exposed surface of the soil in the trench floor.	The entire area of the applicable portion of the trench can be surveyed for radionuclides and vapors.	The entire area of the applicable portion of the trench floor can be surveyed for radionuclides. A systematic grid survey will be conducted over the exposed surfaces of the trench floor for VOC vapors, including locations where sampling in the vent risers indicated elevated VOC concentrations. This sampling design also allows samples to be collected on a judgmental basis, such as using visual observations.
3	Field screening for VOC vapors and radionuclides to identify hot spots in the substrate soils.	Biased sampling design.	A biased approach for vadose zone soil vapor and radionuclide surveys using a cone penetrometer or hand-augering equipment is designed based on data obtained from vent riser sampling activities, visual observations, and trench floor organic and radiological screening if applicable. If no hot spots are indicated using any of the characterization information obtained through this activity, a random statistical sampling design is used to identify soil-vapor hot spots in the vadose zone.
4	Not applicable	Biased sampling design.	The data collection design is based on detection of VOCs or radiation in surveys conducted to resolve DRs 1, 2, and 3. Samples will be collected only in locations where VOCs and/or radionuclides are detected.

Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989).
DR = decision rule. VOC = volatile organic compound.

Before these design options were specified, others were evaluated based on cost and the ability to meet the DQO constraints. The results of the trade-off analyses led to the selection of a design that most efficiently meets all of the DQO constraints without requiring the modification of any outputs from DQO Steps 1 through 4 and the subsequent selection of a design that meets the new constraints.

The following key features of the selected design then are documented:

- Descriptions of sample locations, strata, inaccessible areas, and maps if beneficial
- Directions for selecting sample locations, if the selection is not necessary or appropriate at this time
- Order in which samples should be collected if important
- Stopping rules if applicable
- Special sample collection methods
- Special analytical methods.

7.3 IMPLEMENTATION DESIGN

The sampling design presented in this section was developed to meet the requirements specified in Tri-Party Agreement Interim Milestone M-91-40, Requirement 2. The primary elements of the sampling design, as specified in the milestone, are vapor sampling through vent risers in the trenches before waste retrieval and characterization of the substrate soils beneath the trenches following waste retrieval. This investigation applies only to the retrievably stored suspect TRU waste in the trenches in the 218-W-3A Burial Ground (the portions of the trenches indicated in Figure 1-2).

Resources in the sampling design are focused in areas with the highest potential for detecting the burial ground COCs and moving to additional sampling in a focused manner. This calls for a three-step sampling design. In Step I, the vapor in the vent risers will be sampled and analyzed, an activity expected to have the lowest degree of uncertainty and the lowest cost. In Step II, the sampling design shifts to the trench floor and vadose zone soils beneath the retrieved waste. Visual observations, organic vapor monitoring, and radiological surveys will be conducted on the trench floor. These data, and the data collected during the vent riser sampling conducted in Step I, will be evaluated to determine if additional characterization in the vadose zone soils will be performed for VOCs in soil vapor and radionuclides adhering to sampling equipment as it is retrieved from the subsurface. Step III involves assessing the data collected in Step I and Step II, potentially leading to characterization of the substrate soils beneath the retrieved RSW.

The Step I vent riser sampling will be conducted before waste retrieval begins. The Step II and Step III sampling to characterize the surface of the trench floor, vadose zone soils, and substrate soils will be conducted when the entire RSW portion of the trench floor has become accessible and sampling activities will not interfere with waste retrieval operations.

Changes to the sampling design may be required because of unexpected field conditions, new information, health and safety concerns, waste left in place, or other unforeseen conditions. Minor changes that have no adverse effect on the technical adequacy of the job (i.e., on the DQOs) or schedule can be made in the field with approval by the project manager or assigned task lead and can be documented in the daily field logbook and/or field summary reports. Changes that affect DQOs will require concurrence by the U.S. Department of Energy, Richland Operations Office and the lead regulatory agency and can be documented through unit managers' meetings. Alternatively, if substantial changes are required, the SAP can be revised with U.S. Department of Energy, Richland Operations Office and regulator approval.

7.3.1 Step I Characterization

The main component of Step I of the sampling design is vapor sampling through vent risers at the 218-W-3A Burial Ground. The following activities make up Step I sampling.

- Accessible vent risers will be sampled for VOC vapors. Sampling will be limited to the vent risers that currently exist, that are in sections of trenches that currently contain RSW, and that are accessible without posing health and safety risks to workers (for example, because of the potential for subsidence). Trenches T-05 and T-08 have vent risers in sections containing RSW.

- Vapor samples will be collected in Tedlar[1] Bags or introduced directly into the instrument for onsite analysis using a field-screening instrument capable of analyzing for a limited number of organic compounds. A field screening instrument such as an organic vapor monitor (OVM) will be used to provide real-time feedback on potential organic contamination.

- Additional vapor samples will be collected in SUMMA[2] canisters for laboratory analysis.

- Step I sampling results will be used to guide locations for sample collection during Step II sampling (i.e., locations not associated with the statistically based hot spot random sampling design).

The Step I characterization features are summarized in Table 7-2.

[1] Tedlar is a registered trademark of E. I. du Pont de Nemours and Company, Wilmington, Delaware.

[2] SUMMA is a trademark of Moletrics, Inc., Cleveland, Ohio.

Table 7-2. 218-W-3A Burial Ground Sampling Design. (3 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Step I Sampling		
Vapor sampling from vent risers in 218-W-3A Burial Ground trenches	Sample vapors from accessible vent risers in sections of trenches containing RSW. Collect vapor samples in Tedlar* bags (or draw the samples directly into the analytical instrument) for onsite analysis using field-screening instrument. Collect a vapor sample in a SUMMA* canister for laboratory analysis from the vent riser in each trench with the highest VOC concentration, based on field-screening results. To the extent possible, sample all accessible vent risers in the 218-W-3A Burial Ground during one sampling event, which may extend over multiple days. Use analytical methods that identify individual VOCs in vapor mixtures.	Vent risers offer a simple and inexpensive means of vapor sampling in burial ground trenches. Results can be used to focus Step II sampling.
Step II Sampling		
Surveys of the trench floor using an organic vapor monitor and radiological field detectors.	Using appropriate field-screening instruments, including an OVM, perform a systematic grid survey over the exposed surfaces of the trench floor. Include locations where Step I vent riser sampling and observations made during waste retrieval indicate the potential for elevated VOC concentrations.	Locations on the trench floor with elevated concentrations of organic vapors or radiological activity provide a basis for identifying potential contamination areas in the soil beneath the trench floor.
Visual observations of the trench floor.	During the surveys, examine the trench floor, looking for indications of discoloration caused by organic solvents leaking from drums.	Stains on the trench floor may indicate organic solvent pathways through the trench floor to the substrate soils. This is a basis for Step III sampling.
Review of inspection records and/or occurrence reports.	Review the pertinent 218-W-3A Burial Ground trench inspection records and/or occurrence reports regarding subsidence and/or flooding for indications of biased sampling locations.	Review may indicate locations for biased sampling.
Evaluate data from Step I and Step II characterization performed to this point.	Decision makers review existing characterization data to determine the need for additional characterization.	Detected contaminant concentrations, uncertainties, and costs are weighed to determine the need for additional characterization.
As needed, soil-vapor sampling in the vadose zone beneath the trench floor using a direct push technology (e.g., CPT) or auger.	Based on the results obtained in Step I and Step II, determine whether to use a direct-push technology to access the vadose zone for soil-vapor sampling at locations of elevated VOC concentrations. At each sampling location, collect soil-vapor samples in Tedlar bags (or draw the samples directly into the analytical instrument) at depths of 1.8 m (6 ft) and 3.7 m (12 ft) bgs. Analyze the samples for VOCs using field-screening instruments.	Soil-vapor sampling may locate areas where organic solvents have penetrated the substrate soils. These are potential organic contaminant pathways into the vadose zone.

Table 7-2. 218-W-3A Burial Ground Sampling Design. (3 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
As needed, soil-vapor sampling in the vadose zone beneath the trench floor using a direct push technology (e.g., CPT) or auger (cont).	Decision makers evaluate the use of a direct-push technology for subsurface access at 7.6 m (25-ft) intervals using a systematic grid sampling design with a random start location. If implemented, collect soil-vapor samples in Tedlar bags (or draw the samples directly into the analytical instrument) at depths of 1.8 m (6 ft) and 3.7 m (12 ft) bgs at each sampling location. Analyze the samples for VOCs using field-screening instruments.	Laying out a systematic grid is a hot-spot search technique that could investigate substrate soils in areas where data from surveys or visual observations are not available to indicate the potential for elevated VOCs.
	As needed, use a direct-push technology to collect additional soil-vapor samples at locations between the initial locations with elevated VOC concentrations. At each sampling location, collect soil-vapor samples in Tedlar bags (or draw the samples directly into the analytical instrument) at depths of 1.8 m (6 ft) and 3.7 m (12 ft) bgs. Analyze the samples for VOCs using field-screening instruments.	Soil-vapor samples that are collected at locations between the initial locations are used to reduce the grid spacing and better define any VOC hot spots.
	If soil-vapor concentrations detected at 1.8 m (6 ft) or 3.7 m (12 ft) bgs indicate the presence of contaminants of concern, decision makers will evaluate whether to use direct-push technology to conduct deeper soil-vapor sampling adjacent to the initial locations with elevated VOC concentrations that appear to define a VOC plume in the vadose zone. In these locations, the sampling will be conducted using a direct-push technology (e.g., CPT) for subsurface access. At each sampling location, soil-vapor samples will be collected in Tedlar bags at 1.8 m (6-ft) intervals below ground surface until refusal or until reaching a maximum depth of approximately 9.8 m (32 ft) below the surface of the substrate soil. The samples will be analyzed using a field-screening instrument.	The initial results will be used to guide vertical profiling for VOCs.
	At the location in an apparent plume with the highest VOC concentration(s) based on field screening, collect soil-vapor samples in SUMMA canisters for laboratory analysis. At these locations, sample at 1.8 m (6-ft) intervals below ground surface until refusal or until reaching a maximum depth of approximately 9.8 m (32 ft) below the depth of the trench floor. If no VOC plumes are apparent at a given trench, laboratory samples will not be collected.	
	If organic contaminants are detected in soil-vapor samples, the decision as to how to move forward will be determined through the cleanup processes set forth in RCRA and/or CERCLA.	Sampling beyond this sampling design will be conducted at the discretion of the decision makers.
Step III Sampling		
Evaluate data from Step I and Step II characterization.	Decision makers review existing characterization data to determine the need for additional characterization.	Detected contaminant concentrations, uncertainties, and costs are weighed to determine the need for additional characterization.

Table 7-2. 218-W-3A Burial Ground Sampling Design. (3 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
As needed, sample the soils beneath the trench floor.	Collect soil samples at a depth of 0 to 15.2 cm (0 to 6 in.) at locations determined by Step II characterization results. Collect samples using hand tools. Alternatively, use a direct-push technology (e.g., drive casing) for access to the desired depth and collect samples using a device such as a split-spoon sampler. Analyze for the constituents that were detected on the trench floor surface or in vadose zone soils (e.g., if chemical constituents were detected, analyze for chemical constituents. If radiological constituents were detected, analyze for radiological constituents).	Soil samples can provide data on all contaminants of concern at specified depths below the trench floor.
	If contaminants are detected in soil samples, the decision as to how to move forward will be determined through the cleanup processes set forth in RCRA and/or CERCLA.	Sampling beyond this sampling design will be conducted at the discretion of the decision makers.

*Trademarks:

Tedlar is a registered trademark of E. I. du Pont de Nemours and Company, Wilmington, Delaware.
SUMMA is a trademark of Moletrics, Inc. Cleveland, Ohio.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.
Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.

bgs = below ground surface.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
CPT = cone penetrometer.
OVM = organic vapor monitor.
RCRA = *Resource Conservation and Recovery Act of 1976.*
RSW = retrievably stored waste.
VOC = volatile organic compound.

7.3.2 Step II Characterization

Step II includes surveying the exposed trench floor using appropriate field-screening instruments after waste retrieval. Following these surveys, decisions for additional characterization will be made. Several options for additional characterization techniques are available during Step II. The decisions on which of the techniques to implement will be based on the data obtained during previous surveys and/or characterization activities. The complete list of Step II activities is as follows.

- Pertinent inspection records and/or occurrence reports regarding subsidence and/or flooding in the 218-W-3A Burial Ground trenches will be reviewed for indications of biased sampling locations. Observations made during waste retrieval also will be reviewed to indicate possible judgmental survey and sampling locations.

- Surveys using radiological and organic vapor monitor field detectors and visual observations will be performed over the exposed area of the trench floor following waste retrieval. The surveys will be made when the trench floor underlying the RSW has become accessible and sampling will not interfere with waste retrieval operations.

The results of these surveys and visual observations will be documented and evaluated for obvious indications of locations for substrate soil characterization.

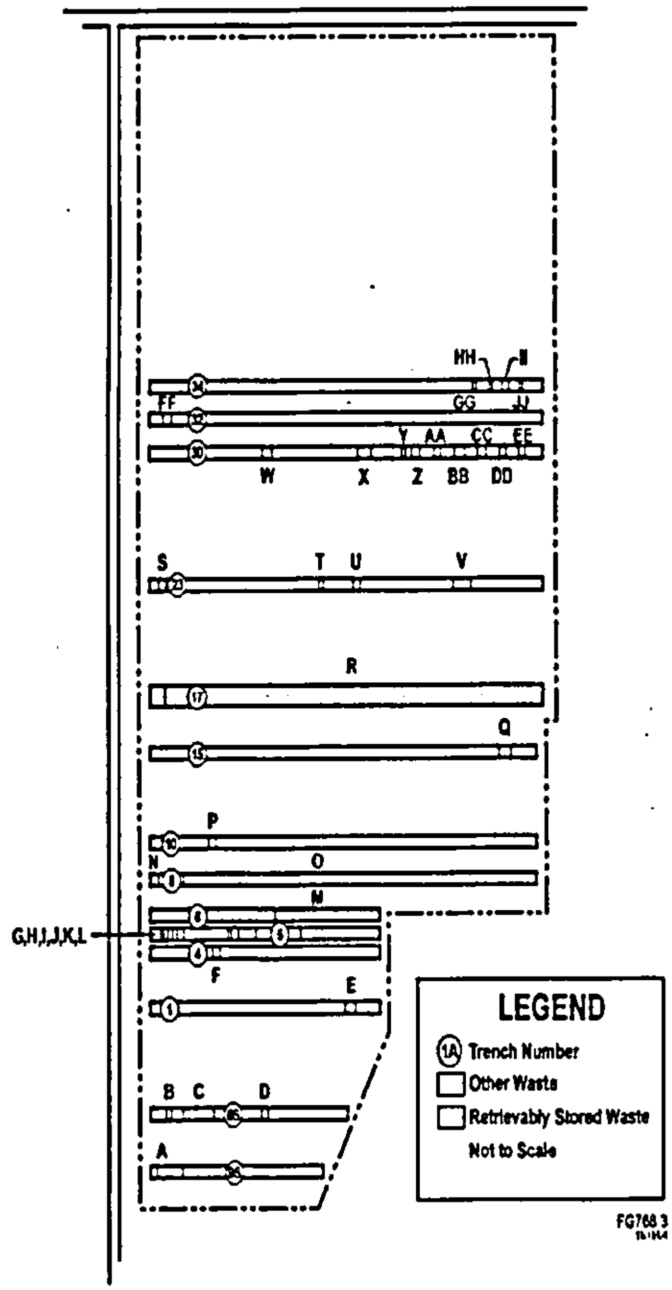
- During the surveys, the soil at the trench floor will be examined for indications of discoloration, staining, or bleaching that could be caused by leakage of organic solvents or other liquid waste from drums. This evaluation of the trench floor soil provides a basis for Step III sampling.

- At locations where characterization data obtained in Step I or Step II activities indicate a potential hot spot, soil-vapor sampling using a direct-push technology (e.g., CPT) or hand auger will be performed.

- If no potential hot spots were indicated by previous characterization activities, decision makers will evaluate whether substrate soil-vapor characterization using a direct-push technology (e.g., CPT) or hand auger should be performed in a grid pattern aimed at locating hot spots (Appendix A). The presence of hot spots indicates locations where contained waste may have drained into the substrate soils. The sampling locations for the grid survey (if needed) will be as described in Appendix A and will be augmented by the results of activities conducted in Step I and Step II. As needed, sampling locations will be spaced at 7.6 m (25-ft) intervals. Figure 7-1 summarizes the trench floor sampling locations, lengths, and estimated number of samples. Figure 7-2 shows an example of sampling locations for substrate/vadose zone soils in Trench T-06. A random number generator will be used to determine the location of the first sampling location from the corner of the applicable section of the trench. At each sampling location, soil-vapor samples will be collected at 1.8 m (6-ft) and 3.7 m (12-ft) depth intervals below ground surface and collected in Tedlar bags (or drawn directly into the analytical instrument) for field-screening analysis or in SUMMA canisters for laboratory analysis. Also at each location, the CPT rods or hand-augering equipment will be surveyed by hand-held radioactivity detectors upon their removal from each location. If the trench floor is not accessible by vehicle, depths greater than those achievable with a hand auger will not be sampled. Additional sampling locations may be established between the 7.6 m (25-ft-) spaced locations to reduce the grid size and better define potential hot spots, based on results of Step I and Step II characterization and/or visual observations.

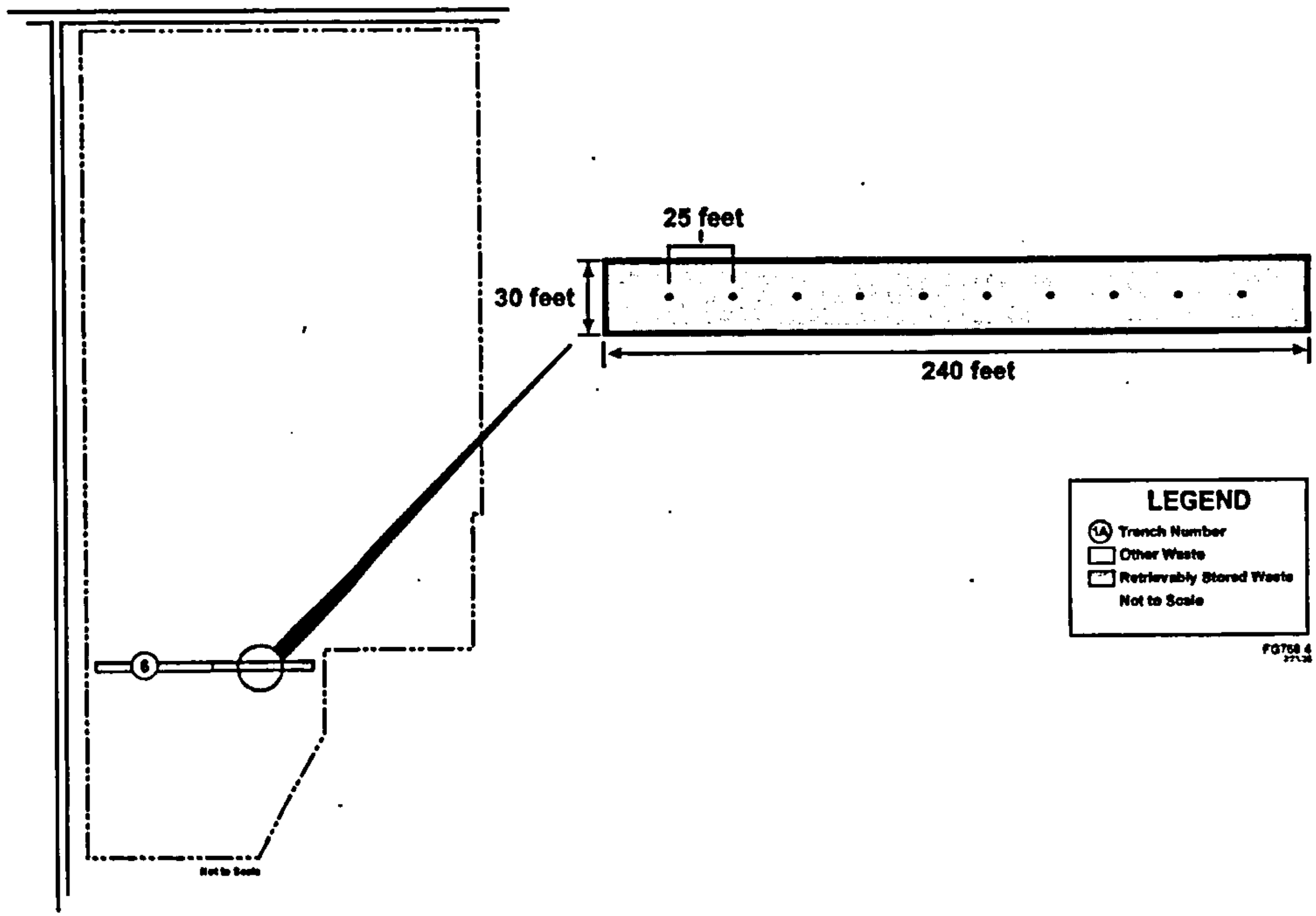
- Deeper soil-vapor sampling will be conducted using a direct-push technology (e.g., CPT). Samples will be taken adjacent to the initial locations, with elevated vapor concentrations that appear to define a VOC plume. Samples will be collected at 1.8 m (6-ft) intervals below ground surface until refusal or until a maximum depth of approximately 9.8 m (32 ft) below the trench floor is reached. The samples will be analyzed using a field-screening instrument.

Figure 7-1. Summary of Sampling Locations for Soil-Vapor Sampling and Radiation Surveys in Vadose Zone and/or Substrate Soil.



Trench Number	RSW Location	Length (ft)	Maximum Number of Samples
T-9S	A	90	4
T-6S	B	12	1
T-6S	C	94	4
T-6S	D	27	2
T-01	E	28	2
T-04	F	24	1
T-05	G	7	1
T-05	H	22	1
T-05	I	26	2
T-05	J	16	1
T-05	K	92	4
T-05	L	192	8
T-06	M	240	10
T-08	N	29	2
T-08	O	808	33
T-10	P	18	1
T-15	Q	15	1
T-17	R	924	37
T-23	S	9	1
T-23	T	7	1
T-23	U	13	1
T-23	V	28	2
T-30	W	21	1
T-30	X	25	1
T-30	Y	8	1
T-30	Z	11	1
T-30	AA	15	1
T-30	BB	11	1
T-30	CC	13	1
T-30	DD	10	1
T-30	EE	18	1
T-32	FF	15	1
T-34	GG	13	1
T-34	HH	15	1
T-34	II	30	2
T-34	JJ	13	1

Figure 7-2. Random Sampling Design for Soil-Vapor Sampling and Radiation Surveys in Vadose Zone and/or Substrate Soil.



Soil-vapor sampling using direct-push technology generally will involve one-time installation of direct-push rods and vapor sampling, followed by removal of the rods. However, in locations with elevated vapor concentrations, the project may elect to leave the rods in place for longer-term vapor sampling or may install temporary vapor sampling stations (e.g., using sintered metallic filters). Direct-push technology rods that are left in place will be completed at the upper 45.7 cm (18 in.) with concrete pads and brass survey markers (consistent with groundwater well installations).

An advanced drive-point technology, the wire-line CPT, is being considered for collecting soil-vapor samples. The wire-line CPT avoids a potential difficulty inherent in direct-push sampling: removing the rods and reinserting them in the same hole. Several advanced characterization tools can be used with the wire-line CPT to sample soil vapor in the vadose zone. The wire-line CPT vapor sampler can be used to draw soil-vapor samples to the surface for analysis and the wire-line CPT grouting module can be used to grout the hole after sampling has been completed.

Use of these characterization tools will depend on their availability, cost-effectiveness, and capability in fulfilling the sampling objectives for this investigation. If trucks are not allowed in or near the 218-W-3A Burial Ground trenches, hand-augering equipment will be needed to penetrate into the substrate soils. Soil-vapor samples then can be collected in SUMMA canisters or Tedlar bags (or drawn directly into the analytical instrument) for analysis.

The Step II Characterization features are summarized in Table 7-2.

7.3.3 Step III Characterization

Step III activities involve sampling substrate soils. To determine if this intrusive characterization is required, the results of the Step I and Step II characterization activities will be evaluated by decision makers. During the review, decision makers will weigh detected contaminant concentrations, uncertainties, and costs. If the Step I and Step II data evaluations indicate a need for Step III characterization, the following methods will be considered as needed.

- Soil samples will be collected to represent the first 15.2 cm (6 in.) of exposed soil in the trench floors. If an engineered fill that resembles gravel or cobble is present, the sampling depth will be 0.6 m (2 ft) below the onset of native soils.

- These samples will be analyzed in the laboratory for the full suite of VOCs, SVOCs, metals, and radionuclides. If contaminants are detected in soil samples, the decision about how to move forward will be made through the cleanup processes set forth in RCRA and/or CERCLA.

The Step I, Step II, and Step III sampling design features are summarized in Table 7-2.

7.3.4 Potential Sample Design Limitations

The sampling design might not fill all vadose zone data gaps. As presented, the sampling design allows for reassessment of characterization, remediation, and financial priorities. This approach recognizes that decision makers will be in a better position to initiate expensive, deep vadose zone characterization after conceptual model data gaps have been filled.

Other potential limitations of the proposed sampling designs are as follows.

- Access to the burial ground vent risers soil before waste retrieval, and to substrate soil following retrieval, could be limited because of worker protection requirements or other constraints.
- Some items still may be present in the trench that could limit access to the certain substrate soil locations for this sampling activity.
- Backfill placed over waste that is adjacent to the RSW but that will not be retrieved may limit access to certain substrate soil locations for this sampling activity.

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APPENDIX A

SAMPLING DESIGN FOR THE IDENTIFICATION OF HOT SPOTS IN SUBSTRATE SOIL

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APPENDIX A

SAMPLING DESIGN FOR THE IDENTIFICATION OF HOT SPOTS IN SUBSTRATE SOIL

A1.0 INTRODUCTION

This sampling design will be used to investigate the occurrence of organic soil vapor and radionuclide hot spots in the substrate soils following waste retrieval in portions of the 218-W-3A Burial Ground that contain retrievably stored suspect transuranic (TRU)[1] waste. If organic chemicals are present in the 218-W-3A Burial Ground trenches, they also could be present in condensate that might have entered the substrate soils within the trenches. *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Interim Milestone M-91-40, Requirement 2 (Ecology et al. 1989), requires the U.S. Department of Energy to "sample and analyze trench substrates with the purposes of determining whether or not releases of contaminants to the environment have occurred, and, if so, the nature and extent of contamination."

A1.1 ASSUMPTIONS

The following assumptions were used in developing the sampling design.

- The target (hot spot) is circular or elliptical. For subsurface targets, this applies to the projection of the target to the surface.
- Samples or measurements are taken on a square, rectangular, or triangular grid.
- The distance between grid points is much larger than the area sampled, measured, or cored at grid points (i.e., a very small proportion of the area being studied actually can be measured).
- The definition of a hot spot is clear and unambiguous. This definition implies that the types of measurement and the levels of contamination that constitute the hot spot are clearly defined. For the surface soil-vapor sampling and the substrate soil that will be exposed following waste retrieval in the 218-W-3A Burial Ground trenches, these definitions have been provided in the main text as outputs of steps in the data quality objective process.

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[1]Waste materials contaminated with more than 100 nCi/g of transuranic materials having half-lives longer than 20 years.

- No measurement misclassification errors occur (i.e., no errors are made in deciding when a hot spot has been detected).
- The grid spacing calculations will be applied only to the surface locations in trenches where retrievably stored TRU waste will be exhumed and accessible locations in the substrate soil following waste retrieval.

A1.2 GRID SPACING

The grid spacing required to find a hot spot of a prescribed size and shape with specified confidence may be determined from the following procedure.

1. Specify L, the length of the semimajor axis of the smallest hot spot important to detect. L is one-half the length of the long axis of the ellipse.

2. Specify the expected shape (S) of the elliptical target, where

$$S = \frac{\textit{length of short axis of the ellipse}}{\textit{length of long axis of the ellipse}} \qquad \text{Equation A-1}$$

   Note that $0 < S < 1$ and that $S = 1$ for a circle. If S is not known in advance, a conservative approach is to assume a rather skinny elliptical shape, perhaps $S = 0.5$, to give a smaller spacing between grid points than if a circular or "fatter" ellipse is assumed (i.e., sample on a finer grid to compensate for the lack of knowledge about the target shape).

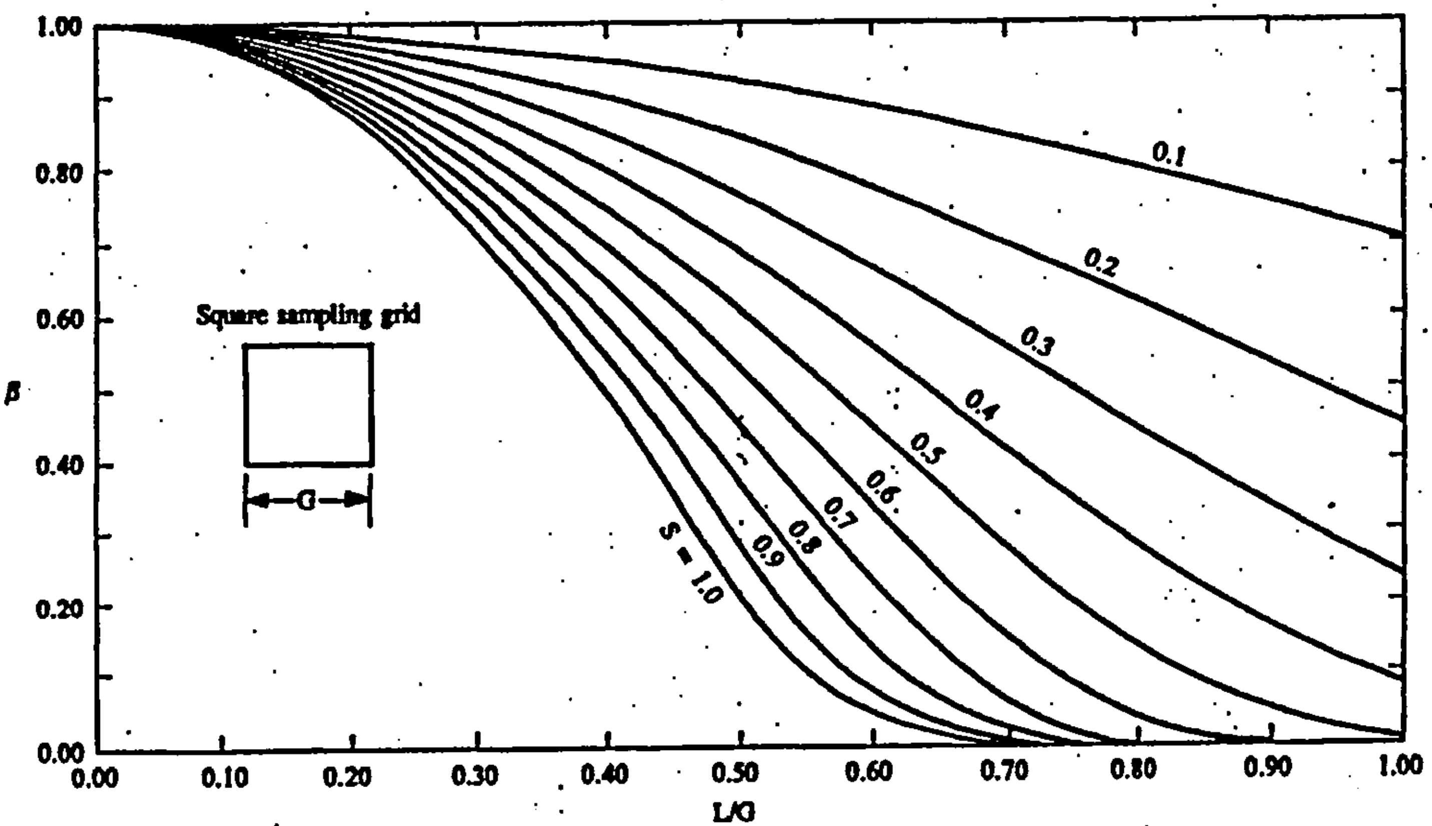
3. Specify an acceptable probability (β) of not finding the hot spot. The value β is known as the "consumer's risk." To illustrate, a probability of 20 percent ($\beta = 0.20$) (one chance in 5) of not finding a hot spot may be acceptable for a small hot spot (e.g., one for which L is 5 cm). However, for a larger hot spot (e.g., one for which L is 5 m), a probability of 10 percent ($\beta = 0.10$) (one chance in 10) of not finding a hot spot may be required.

4. Use Figure A-1 for a square grid. This nomograph gives the relationship between β and the ratio L/G, where G is the spacing between grid lines. Using the curve corresponding to the shape, S, of interest, find L/G on the horizontal axis that corresponds to the prespecified β. Then solve L/G for G, the required grid spacing.

5. The total number of grid points (sampling locations) then can be found, because the dimensions of the land area to be sampled are known.

This procedure is used to establish a square grid pattern in which samples are collected at the four nodes where grid lines intersect. The square grid pattern is relevant to a two-dimensional land surface. This procedure was applied to sampling the soils in the exposed trench floor following waste retrieval. To identify the location of sample points in the square grid pattern, the location of the first sampling point (i.e., grid node) is chosen randomly and the rest of the grid is established with lines parallel to the boundaries of the trench.

Figure A-1. Curves Relating *L/G* to Consumer's Risk, β, for Different Target Shapes when Sampling is on a Square Grid Pattern (after Figure 3 in Zirschky and Gilbert [1984]).



A1.3 SUBSTRATE SOIL HOT-SPOT SIZE

The length of the semimajor axis of the ellipse (i.e., the size of the hot spot) must be defined. The method used to detect the possible presence of a hot spot will be collection of soil vapors at depths of 1.8 m (6 ft) and 3.7 m (12 ft) and radiation surveys conducted on the surface of the substrate soil. If hot spots are detected, subsequent soil samples will be collected to represent the first 6 in. of soil in contact with buried waste. Because the sampling grid used will be augmented by sampling points related to detection of soil vapors in the surface soils and those sampling points added as a result of visual observations of the substrate soil, a rather large hot-spot size can be selected. For this activity, the distance of the semimajor axis of the ellipse of interest (L) will be assumed to be 4.9 m (16 ft). If it is assumed that the shape (S) of interest is 0.8 (i.e., the contaminants of concern have moved only slightly further in one direction from the point at which the hot spot emanates than in any other direction), and the acceptable probability of not finding a hot spot, which correlates to false positive decision error, is 10 percent (this is a consumer's risk, β, of 0.1), the nomograph can be used to solve for the grid spacing (G).

Using the tolerances-specified results in a value for L/G of 0.627, G can be resolved as follows:

$$G = \frac{16\,feet}{0.627} = 25.518\,feet \qquad \text{Equation A-2}$$

Using this sampling design will require collecting samples every 7.78 m (25.518 ft). For practical purposes, a grid spacing distance of 7.6 m (25 ft) will be used, which would correspond to a slight decrease of the semimajor axis size of interest to 4.78 m (15.67 ft). The shape of the trench floor following waste retrieval is expected to consist of sloping sides and a relatively flat bottom. Because detection of residual contamination resulting from leaking waste containers is most likely in the lowest elevations of the trench floor, the sampling grid will be applied only to the bottom of the trench and not to the sloped sides. Therefore, sample collection will be conducted starting at a randomly chosen location within an 7.6 m (25-ft) arc from the southwest corner of the relatively flat bottom of the empty 218-W-3A Burial Ground trench, then once at the nodes of a grid oriented parallel to the trench sides, spaced every 7.6 m (25 ft) apart. If burial ground contaminants of concern are detected in soil vapor or beta/gamma radiation surveys at any of the sample collection locations, soil samples may be collected or decisions about how to move forward will be determined through the cleanup processes set forth in the *Resource Conservation and Recovery Act of 1976* and/or *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*

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